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SOCIO-SPATIAL AND GENDER DISPARITIES IN INFANT MORTALITY IN INDIA

By

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ABSTRACT

SOCIO-SPATIAL AND GENDER DISPARITIES IN INFANT MORTALITY IN INDIA

By

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Infant survival in India as in most developing countries in South Asia is characterized by dual problems of spatial and gender disparities. In spite of considerable progress in social and economic development in recent decades, one in thirteen children still dies within the first year of life and one in every nine children still dies after birth but before reaching age 5. Infant mortality rates vary between as well as within the states in India. In spite of their innate biological advantage, more girls than boys die during infancy. Postneonatal mortality is 13 percent higher for females than for males.

In this dissertation, data from the National Family Health Survey are used to examine the spatial and gender disparities in infant mortality, identify the regions of female disadvantage in survival, and gauge the impact of several independent variables on male and female infant survival. The general objective is to provide a better understanding of the spatial pattern of infant survival and its determinants, the relation between gender and infant mortality and the various factors that lead to a spatial variation between male and female infant mortality. Spatial disparities in infant mortality in

general and male-female mortality in particular (at the district level for all the states) are estimated by the coefficient of variation, Gini coefficient and Lorenz curves and illustrated on maps. Multinomial logit regression models are used to estimate the impact of independent factors on male and female infant survival in rural areas in the states of Uttar Pradesh and Haryana in the north and Kerala and Tamil Nadu in the south.

The analysis confirms that spatial disparities in infant mortality exist between and within the states in India. Most of the northern states experience higher mortality rates than the southern states. The northern region of the country experiences higher female disadvantage in survival. Although female infants in the south have a higher chance of survival than their northern counterpart, they do not experience the full advantage of their biological superiority. The impact of biomedical factors like maternal age and parity is stronger during the neonatal period of life, while sociocultural factors like caste become more important during the postneonatal period. Breast feeding and medical care during pregnancy and at the time of birth significantly improves infant survival and also helps to reduce the gap between male and female survival. Proximity to a health center improves survival only for the male infants both in the north and the south. The effects of a traditional gender bias in Indian society are complex and are evident in the relation between caste, land ownership and the gender composition of the siblings.

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ABBREVIATION

Organizations

PRB	Population Reference Bureau
WHO	World Health Organization
UNICEF	United Nations Children's Fund
PRC	Population Research Centers
USAID	United States Agency for International Development
MOHFW	Ministry of Health and Family Welfare
IIPS	International Institute for Population Sciences
NSSO	National Sample Survey Organization
RGI	Registrar General of India

Technical Terms

NFHS	National Family Health Survey
WFS	World Fertility Survey
IMR	Infant Mortality Rate
NMR	Neonatal Mortality Rate
PNMR	Postneonatal Mortality Rate
LQ	Location Quotient
CV	Coefficient of Variation
GC	Gini Coefficient
Prevbi	Gender of Previous Birth
Premale	Number of Surviving Older Male Siblings
Prefem	Number of Surviving Older Female Siblings
Birthord	Birth Order
Birthint	Birth Interval
Agem	Age of Mother
Edum	Education of Mother
Moccu	Mother's Occupation
Chcare	Childcare
Rehw	Blood Relation between Parents
HFI	Housing Facility Index
Hcom	Household Commodities Owned
PMI	Prebirth Medical Index
BMI	Birth Medical Index
BFI	Breast Feeding Index
BFD	Breast Feeding
Distw	Distance to Water
Distn	Distance to Nearest Town
Distsc	Distance to Susidiary Health Center
Distphc	Distance to Primary Health Center

Disthc	Distance to Government Hospital
D	Distance to Nearest Health Center
Lnhc	Level of Nearest Health Center
PHC	Primary Health Center
CHC	Community Health Center
H	Hospital
SC	Subsidiary Health Center
ORS	Oral Rehydration Therapy

I. INTRODUCTION

The level of infant mortality in India is characterized by spatial and gender disparities. This introductory chapter provides some background information on the geographic, demographic, historical and economic characteristics of the country in order to set the direction, focus and objectives of this research in addressing these spatial and gender disparities in infant mortality.

Background of the Study

India has made considerable progress in social and economic development in recent decades, as significant improvements in life expectancy, infant mortality and literacy demonstrate (The World Bank 1993). Infant mortality rates have declined by 22 percent during the last 20 years. The largest decline has been in the child mortality rate (31 percent). Unlike the developed countries where demographic transition was a direct result of economic development, reductions in infant mortality in India have been largely a result of the diffusion of medical technology. Developing countries like India, Sri Lanka and China have demonstrated that increased child and infant survival can be achieved without massive economic transformation (Caldwell 1986).

Despite these improvements in infant and child mortality in India, 1 in 13 children still dies within the first year of life and 1 in every 9 children still dies after birth but before reaching age 5 (IIPS 1995). The infant mortality rate is 79 per 1000 live births (IIPS 1995). This is extremely high when compared to some of the nations of the world. For instance, the infant mortality rate is 7.0 infant deaths per 1000 live births in the US, 6.0 in Canada and the UK, 5.0 in Germany and France, 4.0 in Sweden, Norway, Finland

and Japan, and 3.0 in Iceland (Population Reference Bureau 1999). In all of these countries the percentage of children dying before the age of 5 years is 1 percent or below. Furthermore, infant mortality rates in India vary dramatically from one state to another, ranging from 15 in Mizoram to 112 in Orissa (IIPS 1995). Such disparities are also evident within the states and between districts. In fact, differences in infant mortality are observed at and within every level of spatial aggregation, namely regions, states, districts, and urban and rural areas.

Since the turn of the century, India's sex ratio has shown male dominance. This is in contrast to the situation in most countries, where females usually outnumber males. In India, high female mortality starts at infancy and persists up to the childbearing ages during which period, despite their innate biological advantages, more girls than boys die. Post-neonatal mortality is 13 percent higher for females than for males (IIPS 1995). This bias continues throughout the childhood years. Between the ages of 1-4 years, females are at a 43 percent higher risk of death than males (IIPS 1995). These differentials in mortality also show regional variation, where the southern states have more parity in the mortality pattern than the northern states.

Problem Statement

The general health of the people of India has improved substantially after independence in 1947. Various committees set up by the government have worked out plans so as to improve the survival of infants in the country. After India became a signatory to the Alma Ata Declaration of 1978 (International Conference on Primary Health, jointly sponsored by the World Health Organization and UNICEF), there has been an effort to commit resources to attain the goal of "Health for All" by the year 2000.

In spite of the general reduction in infant mortality, the infant mortality rate is still high. Furthermore, there are enormous variations in infant mortality between different regions of the country. Also, mortality rates differ between male and female infants. Excess male mortality during infancy and early childhood years is the biological norm (Waldron 1983) and characterizes most developed and underdeveloped countries (Preston and Weed 1976; Hammoud 1977; United Nations 1983). However, most of India is characterized by excess female mortality. Also, there are spatial variations in the male female differential in infant mortality between major geographic regions and states in the country. A large difference in the mortality of female children compared to the mortality of male children indicates gender discrimination in "access to the right to live" (Kishor 1993). Although persistently high mortality among females suggests that females are undervalued relative to males, and that this 'undervaluation' is rooted in economic and cultural factors, few attempts have been made to evaluate the simultaneous contribution of such factors in creating a spatial differential in male/female infant mortality. Also, most of the studies on gender differentials concentrate on the childhood years between 1 and 4 years and/or birth to 4 years. Few studies have focused on the first year of life in order to ascertain the role of gender in infant survival and to examine whether the factors that create gender differentials during the childhood years are equally active during infancy, so as to create spatial variations in the differential between male and female infant mortality.

This study starts with the assertion that disparities in infant mortality exist in terms of space and gender. Therefore, it intends to identify the regions, which experience high and low infant mortality, and those that suffer from a female disadvantage in infant

mortality. Specifically, the focus of this study is to describe the spatial disparities in infant mortality and analyze and explain the determinant factors affecting infant mortality with special reference to gender. In this research I attempt to fill the lacuna in the study of infant mortality by analyzing infant mortality in present-day India, and examining the effect of the same independent factors separately on the male and female infant in order to assess how these factors affect male and female survival differently in the two major regions of the country. In particular, the analysis estimates the differences in survival between the north and the south by reflecting on a combination of geographic, socioeconomic, and demographic variables and examining how they affect infant survival in these two macro regions of the country. Particular attention is paid to the impact of gender and availability of health care on infant survival. Due to data restrictions, the second part of the study, assessing the relation between infant mortality and a plethora of independent variables is limited to rural areas. Data on the availability of health facilities and proximity to these health facilities is limited to rural areas since urban areas have a multiplicity of health centers managed by government as well as private organizations, which are extremely difficult to account for.

Research Objectives

The general objectives of this study are to provide a better understanding of the spatial variations in infant survival and its determinants, the relation between gender and infant mortality in India and the various factors that lead to a spatial disparity in the differential between male and female infant mortality. Although some previous attempts have been made to study disparities in mortality in India, most of these are limited to child mortality and concentrate on macro areas like states or regions. This study looks

into the disparities in infant mortality at the district level. Furthermore, the separate impact of various factors including geographic, socioeconomic, medical, and demographic factors on infant survival and the survival of male and female infants are explained. Although excess female mortality is widely recognized as rooted in geographical, social, economic and cultural factors, few attempts have been made to evaluate the simultaneous contribution of these factors. In this research, I have tried to fill this lacuna by analyzing infant mortality separate from child mortality in present-day India, where excess female mortality in some areas is so great that females are seen as being "endangered" (Miller 1981) and millions are missing (Sen 1990).

The study is organized under four specific objectives. The first objective is to explain and map regional variations in infant mortality at the regional, state and district level. The second objective is to evaluate and compare male female mortality in order to identify areas that experience a disadvantage in female infant survival. The third objective is to gauge the impact of various explanatory factors on infant mortality for the northern and southern rural regions of the country separately. The choice of explanatory variables is partly guided by previous analyses of the determinants of demographic behavior, but also reflects the availability of information from the main data source. Particular attention is paid to the influence of gender and the availability of health care. The fourth objective is to measure the impact of these variables separately for male and female infants, both in the north and the south, in order to understand the differential impact of these factors on the male and female infants in the two major regions of the country.

The Study Area

To understand effectively the various economic, social and cultural factors that are related to the demographic outcome and spatial pattern of infant mortality and especially gender differentials in infant mortality in India, it is necessary to have a basic understanding of the historical and geographical characteristics of the country. In the following paragraphs, I provide a brief summary of the historical events that have shaped modern India since ancient times and the geographic, economic, cultural and demographic features that affect life in India. These characteristics are presented here as a comparison between the northern and southern parts of the country so as to provide a background for the study of regional differences in infant mortality in the country.

India's Historical Background

India is one of the oldest civilizations with a kaleidoscopic variety of people and a rich cultural heritage. Although it is difficult to give a full account of Indian history in a few paragraphs, an attempt is made here to briefly sum up the most important historical events that occurred both before and after India became an independent nation in 1947.

A dark-skinned people, known as the Dravidians, are regarded as the aborigines of India, although the great variety of ethnic types found among the peoples is due to the many migrations into the sub-continent that have taken place during the past 5,000 or 6,000 years. In 1921, excavations in the Indus Valley at the sites of Harappa and Mohenjo Daro have shown that as early as 3000 BC., India was the home of a civilized people, who lived in well-planned towns, practiced agriculture, and were skilled craftsmen. Between 1500 and 200 BC., Aryan tribes from Central Asia streamed into India through the Khyber Pass and other northwest mountain passes and maintained their

supremacy over most of northern India. They imposed their culture on the original inhabitants, and from the combined cultures arose the philosophy, religion, art and letters that were the glory of ancient India. A number of foreign invasions namely Persian and Greek and the rise and fall of several empires marked this period in northern India. It was also a period of religious awakening when for the first time Buddhism and Jainism evolved out of Hinduism.

Southern India was not very much affected by the kingdoms that rose and fell in the northern part of the country, and the historical developments in this region took place more or less independently from the developments in the north. The south's prosperity was based upon its long established trading links with other civilizations. The Egyptians and later the Romans traded by sea with southern India, and later still, strong links were formed with Southeast Asia. Other outside influences, which came to the south of India in this period, included St. Thomas, the Apostle who is said to have arrived in Kerala in 52 AD. To this day, there is a strong Christian influence in that region.

During the medieval period, Muslim invaders from the Middle East raided northern India several times. Within 20 years of incessant raids and battles, the whole of the Ganges basin was under the control of the Delhi Sultanate. Once again events took a different path in the south than in the north. The Muslim invasions did not reach the south until much later, and powerful Hindu emperors still reigned in the south for sometime. Later in the 16th century, the Mughals dominated all of northern India and also parts of the south, while the Marathas had control over the erstwhile state of Maharashtra.

The British, Portuguese, French and Dutch started arriving in India as traders soon after Vasco da Gama's arrival on the coast of modern day Kerala. However, by the early

19th century, India was effectively under British control. The British followed a policy of divide and rule with great success and negotiated distinctly one-sided treaties giving them the right to intervene in local states if they were "inefficiently" run. Under British rule, India made some progress toward the establishment of the vast railway network and the post and telegraph network. However, the local cottage industries in India were almost crippled due to the cheap textiles available from Britain's mills.

After a series of revolts beginning in 1857 with the "Indian Mutiny", India gained independence in 1947, but was divided into 2 parts: India and Pakistan. Following partition, the greatest exodus in human history took place east and west across Punjab in the west and Bengal in the east. Hindus and Sikhs moved into India from West and East Pakistan while Muslims moved out of India. The exodus of Hindus and also some Muslims continues to this day from now Bangladesh to the eastern and northeastern states of India. Partition and this exodus of refugees created some of the major problems in post-independence India. Since independence, India has fought a couple of wars with Pakistan and one with China over border issues.

Throughout history, even the mightiest of India's ancient civilizations did not encompass all of modern India, and today India is still as much a country of diversity as unity. Yet a national consciousness has developed, and ever since independence, India has remained the world's largest democracy. The historical differences between the northern and the southern parts of the country with regard to foreign influence and domination can be cited as being partly reflected in the present-day infant mortality characteristics of the country. For instance, the dominance of the Delhi Sultanate and later the Mughals over northern India is believed to have imposed a cultural antagonism

toward females which could be partly responsible for the gender differences in the well-being of infants, between the north and the south. Also, the influence of Christianity in the south, especially in the state of Kerala could have precipitated sociocultural changes that are now reflected in a relatively higher status of women and better survival of female infants.

Physical Characteristics

India lies between 8 ° 4′ 28″ and 37 ° 17′ 53″ north latitude and 68° 7′ 53″ and 97° 24′ 47″ east longitude. With an area of 3,287,263 square kilometers, India accounts for 2.4 percent of the total world area. India is bounded by China, Nepal, and Bhutan in the north; Afghanistan, Pakistan and the Arabian Sea in the west; Sri Lanka and the Indian ocean in the south; and the Bay of Bengal, Bangladesh and Myanmar in the east. India presents contrasting landscapes of mountains, hills, plateaus, and plains, which are at different stages of evolution. The country can be divided physiographically into regions of the Himalayas, the Great Plains, the Central Highlands, the Peninsular Plateau and the Coastal Plains (Office of the Registrar General and Census Commissioner 1988).

The Himalayas are the highest mountain system in the world and are the youngest in age, extending over 2,500 Km east to west from 150 km to 400 km in width. From the foothills of the Himalayas rise several perennial rivers. The Great Plains, one of the most productive and densely populated lowlands in the world, extend from the Ganga delta and the Brahmaputra valley in the east to the semi-arid plains of Rajasthan in the west. A considerable part of the Ganga Plain is occupied by the states of Uttar Pradesh, Bihar and West Bengal.

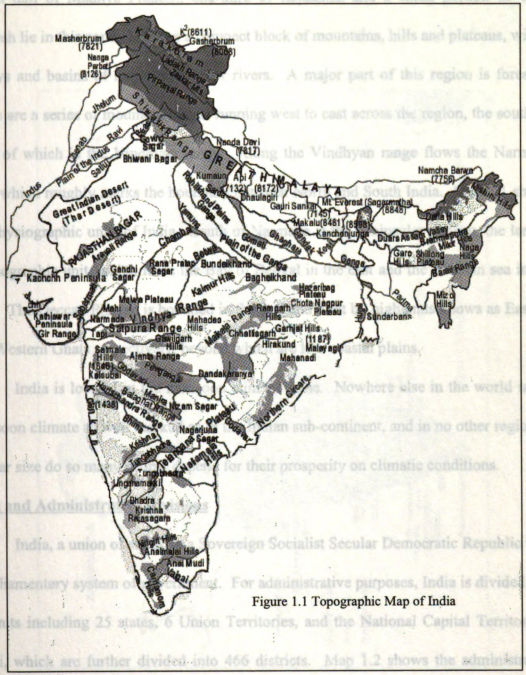

Figure 1.1 Topographic Map of India

The Central Highlands lie between the Great Plains and the Deccan Plateau. About half of Madhya Pradesh, one-third of Rajasthan and a small portion of Uttar Pradesh lie in this zone. It forms a compact block of mountains, hills and plateaus, with valleys and basins of major and minor rivers. A major part of this region is forested. There are a series of mountain ranges running west to east across the region, the southern most of which is the Vindhyan range. Along the Vindhyan range flows the Narmada river which roughly marks the boundary between North and South India. Map 1.1 shows the physiographic units of India. South of Narmada is the peninsular plateau, the largest physiographic unit, which faces the Bay of Bengal in the east and the Arabian sea in the west. The Deccan Plateau is bounded in the east and west by highlands knows as Eastern and Western Ghats respectively, beyond which are low coastal plains.

India is located in the monsoon climatic zone. Nowhere else in the world is the monsoon climate so well marked as in the Indian sub-continent, and in no other region of similar size do so many people depend for their prosperity on climatic conditions.

Area and Administrative Divisions

India, a union of states, is a Sovereign Socialist Secular Democratic Republic with a parliamentary system of government. For administrative purposes, India is divided into 32 units including 25 states, 6 Union Territories, and the National Capital Territory of Delhi, which are further divided into 466 districts. Map 1.2 shows the administrative units of India. The administrative units below the district level are generally known as tahsils in the northern states, taluks in southern states and subdivisions/Community Development blocks/Police Stations in the eastern states and Union Territories.

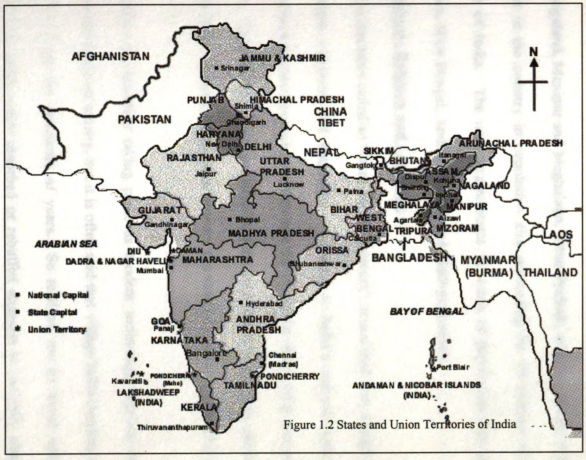

Figure 1.2 States and Union Territories of India

Geographically, Madhya Pradesh is the largest state accounting for 13.5 percent of the total area of the country. Other large states, in order of sizes are Rajasthan, Maharashtra, Uttar Pradesh, and Andhra Pradesh. The smallest state is Sikkim (which is the only state where the National Family Health Survey was not conducted), preceded by Tripura, Nagaland, Manipur and Meghalaya. Uttar Pradesh, which is fourth in land area, stands first in the country in population size accounting for 16 percent of the total population of India. The next largest states in terms of population size are Bihar, Maharashtra, West Bengal, Andhra Pradesh and Madhya Pradesh.

People, Culture, Religion and Language

India has been called an "ethnological museum"; it is a land with a huge variety of ethnic groups, religions and languages. Looking at India's cultural scene, one is generally struck by two contradictory features: the existence of diversity and unity at the same time. Cultural differences between Indians even in the same state, district or city are as wide as the physical differences between the various parts of the country (Kosambi 1981).

Change is inevitably taking place as modern technology reaches further and further into the fabric of society, but it is often said that village India remains essentially the same as it has for thousands of years. So resilient are its social and religious institutions, that India either absorbed or rebuffed attempts to radically change them. Even in fast-paced modern cities like Bombay, Madras, Calcutta, Bangalore and Delhi, what appears to be a complete change of attitude and lifestyle is only surface gloss. Underneath, the age-old verities, loyalties and obligations still strongly influence people's lives.

Hindi in the Devanagari script is the official language in the Union. About 225 languages are spoken on the subcontinent, but there are only about 15 major languages. Religion is inextricably intertwined with every aspect of life in India. There are large numbers of Buddhists, Jains, Muslims, Christians, and Sikhs but the dominant religion of the people is Hinduism. In 1991, there were about 102 million Muslims in India, making India one of the largest Muslim countries in the world, much larger than any of the Arab Middle East nations. Christians number about 20 million, Sikhs 16 million, Buddhists 6 million, and Jains 3 million (Office of the Registrar General and Census Commissioner 1995).

The caste system in India is one of Indian society's unique characteristic features. Historically Indian society has been under the grip of the caste system, segregating the population into thousands of non-associating groups parted from each other by traditional barriers, which forbid common social interaction and intermarriage. Although the origin of the caste system is not very clear, it is thought that the caste system in its earliest form was a division of people in society according to their profession – Brahmins were the religious caste, Kshatriyas, the warrior class, etc. Eventually, the caste system took on the form of dividing Indian society into various groups, which spelt out the status of these groups in society. The caste system became formalized into four distinct castes, each with distinct rules of conduct and behavior. At the top are the Brahmins who are the priests and the traditional arbiters of what is right and wrong in matters of religion and caste. Next come the Kshatriyas, who are the soldiers and administrators. The Vaishyas are the artisan and commercial class and the Sudras are the farmers and the peasant class. Beneath these four major castes is a fifth group, the 'untouchables'. Today the caste

system is much more complicated with numerous sub-groups within these major groups. Although, at present the caste system has considerably weakened, it still has considerable power in dividing Indian society into a hierarchy of social groups, particularly among the less educated and in rural areas.

More than 50 million Indians belong to tribal communities, which are distinct from Hindu caste society. These *Adhivasis*, as they are known in India, have origins, which precede the Vedic Aryans and even the Dravidians of the south. For thousands of years they have lived more or less undisturbed in the hills and densely wooded regions, which were regarded by others as unattractive areas for habitation. Many still speak tribal languages and follow ancient customs, which are foreign to both Hindus and Muslims.

In Indian censuses prior to 1931, information was collected and published for each caste or tribe separately. Pursuant to the policy of the Government of India to discourage community distinctions based on caste or creed, the 1951 census made a complete departure from the traditional recording of caste or tribe. It was thus decided that no inquiry regarding caste or tribe be made, but an inquiry should be made regarding caste or tribe only to the extent necessary for providing information relating to certain special groups of the people who are referred to in the Constitution of India. A statutory list of scheduled castes and tribes are since notified in the Constitution of India. These castes which were considered as scheduled under the Constitution of India represent those who were earlier considered 'untouchables' in the Indian caste system. From the 1951 census onwards, the census questionnaires contained items of inquiry to ascertain whether the respondent belonged to a scheduled caste or a scheduled tribe. The National Family Health Survey has followed the trend set by the census of 1951 in asking respondents

whether they belonged to a scheduled caste or tribe and the same classification has been used in this analysis. Since there are far greater differences between general castes and scheduled castes than among the scheduled castes themselves, a distinction made between the general and scheduled castes can be considered sufficient in bringing out the differences in Indian society based on castes.

Economy

Since independence in 1947, India has made enormous strides but faced enormous problems. The mere fact that India has not, like many Third World countries, succumbed to dictatorships, military rule or foreign invasion is a testament to the basic strength of the country's government and institutions. The British left the Indian economy with deep marks of stagnation. A large proportion of the national income (around 60 percent) originated in agriculture, and a much smaller proportion (around 15 percent) in mining, manufacturing, and the construction sector (Agrawal 1991). The national government responded to the situation with a concerted and coordinated attack, in the form of Five-year plans starting in 1951. While short-term problems were surmounted during the 5-year period of the First Plan, the long-term problem of overcoming lost economic growth continued to be tackled by successive plans. In this process, quite a few advances have been made. The face of the Indian economy as it is today is not only much changed, but is qualitatively a lot different from that in 1951. The presence of large stocks of food grains, a high investment rate, and sizable foreign reserves are symbolic of these achievements. Despite periodic setbacks, the process of economic liberalization is well underway.

A paradox of the Indian situation is that despite overall economic growth, a large proportion of the population continues to live in poverty, often falling short of even minimum calorie needs. According to the estimates of the Planning Commission, 29.9 percent of the population in 1987-88 (33.4 percent in rural areas and 20.1 percent in urban areas) lived below the poverty line. The majority of the poor live in the rural areas and belong to the categories of landless laborers, small and marginal farmers, fishermen and rural artisans. These people have either no assets or assets with very low productivity, few relevant skills and either no regular full-time jobs or very low-paid jobs. The Indian economy also suffers from large inequalities. In rural areas, land continues to be highly inequitably distributed. Small and marginal farmers (with operational holdings of less than 2 hectares) constitute over three-quarters of the landholders, but own only 20 percent of the land. Large farmers (with operational holdings of over 10 hectares) constitute only 2 percent of the landholders, but own more than 20 percent of land (Agrawal 1991). Underemployment and unemployment are standard features of urban economic life in India.

India's economy is predominantly agricultural, but since independence, a concerted effort has been made to diversify the economy. Agriculture contributed 51 percent of the country's GDP in 1950-51 but in 1992-93 its contribution was 26 percent (Center for Monitoring Indian Economy 1994). Yet agriculture is the source of livelihood for over 70 percent of the population in the country. For sometime after independence, India depended on foreign aid to meet its food needs, but in the last 30 years production has risen steadily, mainly due to the expansion of irrigated land and the

increasing use of high-yield seeds, fertilizers and pesticides. India now has large grain stockpiles and is a net exporter of food grains.

The progress of industrialization since independence has been a striking feature of India's economic development. The process of industrialization, launched as a deliberate policy under the Industrial Policy Resolution of 1956 and vigorously implemented under the five-year Plans, involved heavy investment in building up capacity over a wide spectrum of industries. As a result, industrial production multiplied by about five times over the last 40 years. The industrial structure has been widely diversified covering broadly the entire range of consumer, intermediate and capital goods. A great trigger in industrial development has been provided by the rise of the service sector and today India has one of the largest software services in the world. India is one of the newest members of the nuclear club, and most of India's nuclear, satellite and missile development has been indigenous, unlike some of its neighbors.

Basic Demographic Indicators

According to the 1991 Census, India's population is 846.3 million, including the projected population of 7.7 million for Jammu and Kashmir, where the 1991 Census was not held. According to the Population Reference Bureau, Washington, DC, the population of India was estimated to be 986.6 million during mid 1999. India is the second most populous country in the world, accounting for 16 percent of the world's population. Between 1981 and 1991 the population increased by 23.9 percent. In absolute terms, the population of India increased by 163 million during the same period, which is more than the total population of Japan. The percent increase in population during 1981-91 was slightly lower than the percent increase during 1971-81, which was

24.7 percent. The average annual exponential growth rate also decreased from 2.22 percent during 1961-71 to 2.14 percent during 1981-91.

Population density (per km^2) increased from 177 in 1971 to 230 in 1981 and further to 273 in 1991. Nearly three-fourths (74 percent) of the population live in rural areas. In 1991, the sex ratio of the population was 927 (females per 1000 males), which is slightly lower than the sex ratio in 1981. According to the Sample Registration System (SRS) for 1992, 36 percent of the population are children under age 15 and 4 percent are elderly (age 65 and above). The proportion of the population age 0-14 years declined from 42 percent in 1971 to 36 percent in 1992, indicating a decline in fertility during that period.

According to the 1991 census, the literacy rate in India for persons age 7 years and above was 52 percent (64 percent for males and 39 percent for females). The literacy rate increased one and a half times from 34 percent in 1971 to 52 percent in 1991, but it is still very low especially for females. Although the improvement in literacy has been more pronounced for females than males in relative terms, the absolute gap in literacy between males and females remained almost the same during the period 1971-91.

According to estimates derived from the SRS in 1992, India has a crude birth rate of 29 per 1000 population, a crude death rate of 10 per 1000 population, a total fertility rate of 3.6 per woman, and an infant mortality rate of 79 per 1000 live births. The crude birth rate has declined slowly but steadily, from 36. 9 per 1000 population in 1971 to 29.2 per1000 in 1992. The total fertility rate fell from 5.2 to 3.6 children per woman between 1971 and 1992, a decline of over 30 percent. The crude death rate also declined, from 14.9 per 1000 population in 1971 to 10.1 per 1000 in 1992. The infant mortality rate

showed a substantial decline (39 percent) from 129 per 1000 live births in 1971 to 79 per 1000 in 1992. Estimates of life expectancy at birth shows that female life expectancy increased by about 9 years from 49 years in 1970-75 to 58 years in 1986-90. The increase in male life expectancy during this period was 7 years. During the last two decades, the gender differential in life expectancy has reversed; females in India now live slightly longer than males, the pattern observed in most populations.

Health and Family Welfare Policies and Programs

The general health condition of the people of India was very poor before independence with a crude death rate of 22.4 per 1000, an infant mortality rate of 162 per 1000 live births, and an expectation of life at birth of around 26 years. Nearly half of the total number of deaths were among children under 10 years. India was a reservoir of smallpox and endemic diseases such as leprosy, filariasis, guinea worms and hookworms. Sanitary conditions in both rural and urban areas were very poor. The provision of protected water supplies and drainage, and preventive and curative services was totally inadequate (Government of India 1946). The health services and programs after independence were based on the recommendations of several committees convened by the government from time to time.

An important development took place when the country adopted the National Health Policy in June 1981. This development may be viewed as an outcome of the Declaration of Health Issues at the International Conference on Primary Health, jointly sponsored by the World Health Organization and UNICEF at Alma Ata in 1978 (WHO and UNICEF 1978). Delivery of health services is mainly governed by the National Health Policy, which was approved by Parliament in 1983. Although the national health

policy places a major emphasis on ensuring primary health care to all by the year 2000, it nevertheless identifies certain areas, which need special attention. These areas are: (1) nutrition for all segments of the population, (2) the immunization program, (3) maternal and child health care, (4) the prevention of food adulteration and maintenance of the quality of drugs, (5) water supply and sanitation, (6) environmental protection, (7) school health programs, (occupational health services), and (9) prevention and control of locally endemic diseases. Active community participation has been considered to be one of the most important supportive activities for the successful implementation of the health programs.

After India became a signatory to the Alma Ata Declaration of 1978, thereby committing the country to the goal of "Health for All" by 2000 A.D., the government started to concentrate on the development of the rural health infrastructure. This was done to provide health care services to the rural population, which had, by and large, been neglected. Family health care services, including maternal and child health schemes, are offered through the existing network of Primary Health Centers (PHCs), sub-centers, and referral centers called Community Health Centers (CHCs), and also through Village Health Guides and Traditional Birth Attendants at the village level. According to the present infrastructure plan, there is one subsidiary center for every 5000 population, one PHC for every 30,000 population and one CHC for every 100,000 to 120,000 population. In tribal and hilly areas, one sub-center is planned for every 3,000 population and one PHC for every 20,000 population. As of March 1992, there were 20,719 PHCs and 131,464 sub-centers, providing health and family welfare services to the rural population (Government of India 1994). In cities and towns, the health and family welfare services

are provided through a network of government or municipal hospitals and dispensaries, and urban family welfare centers. Private hospitals, clinics and dispensaries also play a major role in providing these services in urban areas.

The long-term national demographic goal is to achieve replacement-level fertility (Net Reproduction Rate 1.0) by 2016. As a part of this goal, the country aims to reduce crude birth rate to 21 per 1000, the death rate to 9 per 1000, and the infant mortality rate to below 60 per 1000 live births. In addition, the recently introduced National Child Survival and Safe Motherhood Program accelerates the goal for infant mortality and introduces additional health goals. The program aims to reduce infant mortality from 80 to 75 by 1995 and 50 by 2000, reduce the child mortality rate (at ages 1 – 4) from 41 to less than 10 by 2000, reduce the maternal mortality rate from 400 to 200 per 100,000 live births by 2000, eliminate tetanus among neonates by 1995, prevent 95 percent of deaths due to measles and reduce measles cases by 90 percent, prevent 70 percent of deaths due to diarrhea and reduce diarrhea cases by 25 percent and prevent 40 percent of deaths due to acute respiratory infection by 2000 (Ministry of Health and Family Welfare 1992).

Organization of the Dissertation

The dissertation is divided into six chapters. Chapter II presents the conceptual framework for the study of spatial and gender disparities in infant mortality and the underlying factors that cause these disparities. This chapter focuses on the available literature on disparity and development on the one hand and infant and young child mortality on the other. The chapter draws from the literature belonging to the disciplines of Geography, Development studies and Demography. In this chapter, important concepts are clarified in order to state the research direction and focus.

Chapter III presents the research methods, and tools of analysis used in this study. First, data collection methods including data characteristics, sampling procedures, enumeration, questionnaire design, and survey instruments as well as compilation and organization of data are presented. In this chapter, the limitations of secondary data and the sources of error are identified and steps of data analysis are discussed. This chapter also presents mathematical and statistical models employed in this study.

Chapter IV presents the general character of the infant mortality situation in the country. First, it presents a view of the temporal changes that have taken place in the infant mortality situation in the country. Second, it presents the distribution of infant mortality in the country using maps. Third, disparities in infant mortality between the states and districts are discussed. Finally, the regions of female disadvantage in infant mortality are identified.

Chapter V presents the relationships between infant mortality and several independent variables in the rural areas of the northern and southern regions of the country. In this chapter, two states each from the north and south are treated as two separate units representing the north and the south respectively.

Chapter VI presents a summary of the conclusions that can be drawn from the research results and their implications for the implementation of the National Child Survival and Safe Motherhood Program. In conclusion, I also identify the limitations of this research and the need for and scope of further analysis.

II. INFANT AND CHILD MORTALITY-A REVIEW OF THE LITERATURE

Infant mortality as a topic has been the subject of intensive investigation by different groups of individuals and institutions belonging to various academic disciplines like demography, economics, geography, medicine, epidemiology, biology, history and sociology. However, no single one of them encompasses the whole topic, nor are these the only disciplines concerned with infant mortality. Infant mortality can be divided into a number of topics, which can be thought of as elements of a 'pattern of death'. Levels of mortality are closely related to place, age, gender, social grouping, and occupation, and are determined by a set of causes which may themselves vary in their relative contribution in time and space. These individual topics have been the subject of investigation by different groups of individuals or institutions. Biologists, doctors and epidemiologists have made great advances in the study of cause of death and illness. For them the relevant questions are how do diseases spread; who catches them; how have causes of illness and death changed and why. Demographers have usually concerned themselves with the statistics of infant births and deaths generally, without looking at the spatial variations (Bourgeois-Pichat 1973). Geographers on the other hand, have usually concerned themselves with the influences of different environments on infant mortality and the ways in which particular infectious diseases are diffused (Banks 1959; McGlashan 1972). They are also interested in discerning patterns in the spatial

distribution of levels of infant mortality and in interpreting these in the light of similar variations in physical, economic and social conditions (Howe 1972).

The study of the spatial pattern of infant deaths leading to the study of various factors that influence this pattern has been a part of geography. Explanations are usually multivariate in approach. One dependent variable is related to a series of independent variables. The choice of explanatory variables is not always internal to geography alone. Economic, social, political, demographic, medical, environmental and technological variables are all involved in attempts to explain the nature of infant mortality and the ways in which it has changed. Nor are these variables always quantifiable. The perceptions, sentiments and attitudes of individuals or groups of people are always likely to influence their behavior, together with the constraints and obligations imposed by governments, institutions and group norms.

It is the aim of this dissertation to study the spatial pattern of infant mortality in India and explain some of the causes of the spatial and gender differentials in infant mortality in India by relating various geographic, cultural, demographic, economic, medical, and social factors. In the following paragraphs, I discuss the existing literature on spatial patterns of infant mortality as well as some of the important cultural, demographic, economic, medical, and social factors that determine disparities in infant mortality. As most factors in infant and child mortality occur simultaneously, this literature review includes references to both of these forms of mortality. Since an exhaustive review of the infant mortality literature is not possible here, only that portion most relevant to the study is discussed.

Key Concepts and Definitions

Three important concepts employed in this study are *infant mortality, neonatal mortality and postneonatal mortality*. The *infant mortality rate* is the probability of death among infants in a given year. It is defined as the number of deaths to those under exact age 12 months per year per 1000 live births during the year. The accuracy of the approximation varies from one situation to another but depends in general on the annual fluctuations in the number of births. Infant mortality varies from place to place and is considered a much better indicator of the level of development of a region than the general death rate, which encompasses all ages of the population. It has been widely used as an indicator of the health conditions of a community and, hence, of its level of living, especially for developing countries where information on income is unreliable and sketchy.

Because of the very high level of mortality in the first hours, days, and weeks of life and the difference in the causes accounting for infant deaths at the earlier and later ages of infancy, the conventional infant mortality rate may be "broken up" into a rate covering the first month and a rate for the remainder of the year. The rate for the first period is called the *neonatal mortality rate* and the rate for the second period is called the *postneonatal mortality rate.*

Spatial Patterns of Infant Mortality

Infant mortality is often used as a measure of development. Like development itself, infant mortality can be visualized in terms of tangible spatial structures. The patterns these structures form are of interest in geography and other development related studies. Spatial patterns can be expressed in terms of scale, distance, direction, mass,

diffusion rate and nearest neighbor and can be used to show perceived changes in a landscape (Dacey 1962; Morrill 1963; Cohen and Rosenthal 1971).

The dynamic nature of spatial patterns of development or any of its components, which results from an on-going process, brings to the forefront the question of the direction of change (Haggett 1979). Social scientists use statistics and data from various sources, such as documents, reports and case studies, to measure and analyze spatial and temporal patterns of development (Williamson 1965; Berry 1960, 1961; Board et al. 1970; Weinand 1973). Given the present meaning of development, the major obstacle in measurement is the difficulty in quantifying its social and welfare aspects (Seers 1972). Researchers sometimes use a single quantitative index (mostly GNP) to generate coefficients, which they use to show spatial patterns of development (Williamson 1965; Board et al. 1970). Recent studies advocate using several indicators for better results. No universal set of indicators has been developed (Axinn 1978) but the use of a multiple index of socioeconomic indicators is emphasized (Haggett 1979). Berry (1960), Board et al. (1970), Smith (1977), and Weinand (1973) amply demonstrate the generation of multiple index patterns of development. In an attempt to study the changes taking place in India with increased development, Ilina Sen (1986) studied the geography of secular change in the sex ratio in India between 1901 and 1981. While studying the spatial patterns in the change in the sex ratio, she found that a significant decline in sex ratio during this period resulted in a decrease in the proportion of women in the population although she identified some areas where the ratio had increased. Berry (1961) used factor analysis on 43 rank-ordered variables to analyze economic development in 95 countries in order to identify basic global patterns of economic development. "Ranks

were chosen rather than the actual value of each index…because more faith was placed in the relative positions of the countries than in the precise value of any index…"

Weinand (1973) and Board et al. (1970) use a regression model to analyze several socioeconomic variables (GNP, education, age, transportation, urban hierarchy, urban water supply, and urban electricity output) to identify variations in levels of development in Nigeria and South Africa. Less sophisticated statistics, such as rank- correlation and descriptive statistics, are also widely used in analyzing relationships between development indicators and development outcomes. The indices used in any study and the correlations sought, depend on the nature and availability of reliable data and also on the spatial units in which the data are collected.

The most frequently used indicators, in the less developed countries (LDC) where the vital statistics are unavailable or unreliable, include extension services, fertilizer consumption, school enrollment, health facilities and personnel, road transport and water supply. These indicators are used in generating coefficients of variations for analyzing patterns. Other measures are used to complement the scale measures, in order to emphasize mathematically and graphically various inequalities in regional studies. These measures include the Lorenz curve and the Gini index (Smith 1977; Darden and Tabachneck, 1980) and location quotient (Isard, 1963). Darden and Tabachneck's statistical program computes and plots an adaptation of a Lorenz curve and summarizes the resulting distributions in terms of Gini, segregation and fair-share point indexes. These indexes are not perfectly correlated with each other but can be useful for measuring the magnitude of spatial, temporal and social inequalities in development. The location quotient is used, "for comparing a region's percentage share of a particular activity with

its percentage share of some basic activity..." (Isard 1963). Thus it is a useful measure for social welfare conditions which emphasize per capita distributions. Even though these measures (Lorenz curve, index of segregation, Gini index, fair-share point index and location quotient) do not give any clues to scale of development, they provide powerful ways of analyzing spatial, social and temporal inequalities.

Two recent studies have mapped the spatial pattern of gender disparities in child mortality in India (Murthi, Guio, and Dreze 1995; Malhotra, Vanneman, and Kishor 1995). Child mortality includes all deaths occurring up to the age of 5 years. The factors affecting infants can be different from those affecting children between 1-5 years of age. Hence, these studies do not focus on the particular factors that impact survival during the first year of life. These are the only two studies that mapped gender differentials in child mortality at the district level. However, no statistical analysis was done to support the maps depicting spatial disparities. A few earlier papers (Jain 1985; Miller 1981) also discussed disparities between regions but most of these were at the broad state level and none had any supportive statistical analysis accompanying the maps.

Some earlier studies (Roberts 1952; Farley 1965; Higman 1973) have used life tables to demonstrate the conditions of mortality during the first six years of life for children of people working as slaves on nineteenth-century West Indian plantations and highlight the local spatial differences in the mortality experience of young children. Another study by Gardner and Donnan (1977) reflects on the regional variations of infant mortality in the boroughs of England and Wales and demonstrates the degree to which particular areas, because of their economic and social background, can experience significantly different 'patterns of death' within the same country. They explained these

differences between the northern and the southern parts of the country as being a result of occupational hazard, chronic unemployment, lack of medical care and poverty. Another comparable study was done by Cousens (1960) to evaluate the regional demographic impact of the Great Famine in the mid-nineteenth-century in Ireland.

The spatial patterns of disease-specific mortality and specifically infant mortality have been the subject of several studies (Pyle 1969; Howe 1970). In examining rural urban differences in mortality, Benjamin (1964), Glass (1964) and Flinn (1965) point to the unhealthy sanitary conditions in England during the early 20th century. Investigations on the spread of infectious diseases, together with their social, economic and demographic influences have been an important topic in the research on spatial aspects of infant mortality. Diffusion of diseases like the bubonic plague, smallpox and cholera were singled out for some of the earlier studies (Briggs 1961; Drake 1962; Edward 1969; Shrewsbury 1970; Hollinsworth 1971; Biraben 1975, 1976; De Panta and Livi-Bacci 1977; Wrigley 1972; Hatcher 1977; Rosenthal 1973; Slack 1977).

Another aspect of the spatial study of infant mortality has been the study of the spatial pattern of decline in mortality (Howe 1970, 1972). There is a variety of ways in which mortality patterns have been created and changed over time and through space, to the extent that the situation in a specific place at one point in time may be unique. However, it is undeniable that chance occurrences, improvements in the standard of living, in the social and physical environment, and medical conditions have all had an influence in some place at some time. From the evidence available, it seems that the recent decline in mortality experienced in many countries in the Third World has been the result of medical improvements, whilst that occurring in industrialized countries from the

mid-nineteenth century was due more to environmental changes, particularly in living standards and public health. Before that time the situation is still uncertain, but the influence of catastrophic events was important since it was these random occurrences that helped to keep mortality and most especially infant mortality at a very high level. The impact of cyclones, floods, pandemics, and famine has also been of considerable influence in the developing countries in the nineteenth and twentieth centuries.

It follows from these statements that environmental differences, medical provision, geographical conditions, socioeconomic conditions and fortuitous occurrences variously influence the spatial distribution of infant mortality. Often some factors can have both negative as well positive impacts on infant mortality. For instance, regional industrialization can bring with it mixed blessings, by improving the standard of wages on one hand and deteriorate the physical environment resulting in poorer health on the other. Also, the advances in medical technology can exhibit a variety of geographical lags, which can create varying spatial patterns of infant mortality.

Mortality research including infant mortality, like fertility research has traditionally been marginalised in favor of migration studies within the discipline of geography. However, as Sporton (1999) has pointed out, for sometime, notable attempts are being made (Woods 1979, 1982) "to integrate the disciplines of population geography and demography in a spatial demography where demographic analysis of fertility and mortality are given a spatial and hence more 'mainstream' geographical focus.

Factors Determining Infant Mortality and its Spatial Variations

Most of the older researches on infant and child mortality have focused on the biomedical factors of mortality from specific diseases and their vectors. However, there is now a growing awareness of, and need for, studies relating the socioeconomic, geographic, demographic and cultural determinants of differentials in levels of infant and child mortality (Johnson et al. 1989; Hill and Pebley 1989; Nag 1983; Behm 1983; Sandiford et al. 1995; Jain 1985; Kost and Amin 1995; Defo 1995; Shariff 1987; Orubuloye and Caldwell 1987; Visaria and Visaria 1995).

Mosley and Chen (1984) have tried to integrate the approaches of social and medical science to identify proximate determinants of children's health dealing with demographic, health and nutrition factors. It is posited that all these factors are influenced by socioeconomic determinants which include (1) individual level variables like education and occupation, (2) household level variables like income and housing characteristics, and (3) community level variables like the health care system. All three categories of variables appeared important in a study of Sri Lanka, where Trussel and Hammerslough (1983) found a very strong association between infant/child mortality and parental education, time period of birth, urban/rural/estate residence, ethnicity, gender, age of mother at birth and toilet facility. All three categories of factors might also illuminate regional disparities in infant mortality. Dyson and Moore (1983) grouped the Indian states into two basic regions, the north and the south, and attributed the lower child mortality in the south to the higher autonomy of women and the availability of better modern health care in the south. Nag (1985), on the other hand, in his comparative study

between the states of Kerala in the south and West Bengal in the east, attributed the lower mortality in Kerala 'mostly to its higher social development and partly to its favorable environmental and hygienic conditions'. In his study, development of social services, such as education, health and policy measures was designated as social development. In summing up his analysis on regional differences in infant mortality in India, Jain (1985) concluded that factors relating to health care could explain about 64 percent of the regional variations in infant mortality while poverty and women's literacy could explain 60 percent of the variation, because these factors overlap.

In determining the factors of infant and early childhood mortality in Cameroon, Defo (1985) found that household income, ethnicity, and disease prevention through vaccines have a strong impact on child survival. Kost and Amin (1995) have studied the reproductive and socioeconomic determinants of child survival in the state of Punjab, India, and found that mother's education is the only socioeconomic factor that shows a strong and significant effect on survival in the early infant ages. Da Vanzo and Habicht (1986) identified several factors contributing to the dramatic decline in infant mortality in Malaysia since World War II. They found improvements in mother's education, sanitation and water contributed toward the decline.

The Role of Health Care

In a study evaluating the common characteristics of poor countries that have low mortality rates, Caldwell (1986) examined the populations of Kerala in India, Costa Rica, Sri Lanka and China. China with a low per capita income has reached a life expectancy at birth of 67 years. The figures for Kerala, Sri Lanka and Costa Rica are 66, 69 and 74 years respectively. These regions have attained levels of life expectancy at birth

comparable with the developed industrial market economies, with little more than a tenth of their per capita income. (Caldwell 1986). Clearly, these examples indicate that third world countries can achieve high levels of demographic health by applying appropriate medical technology and social institutions. Based on these examples, Caldwell has described a list of routes that would most probably lead to low mortality in poor countries. These include (a) improved status of women and greater female autonomy, (b) socio-spatial accessibility to health services, (c) efficient mass education system, and (d)grass roots participation in the politics of the country.

In all cases of improved life expectancy, irrespective of low per capita incomes, health care has played a very important role. An intriguing comparison can be made in terms of the health provision between the lowland, midland, and highland regions of Kerala, where the number of hospital beds per 100,000 population were 142, 87 and 46 respectively. The average areas served by each health facility were 11, 25, and 40 square miles. Presumably as a direct result of these differentials, the proportions of births with medical assistance were 59, 44, and 36 percent respectively, and the average infant mortality rates were 47, 47 and 78 respectively (Krishnan 1976).

In Sri Lanka, the greatest decrease in mortality was observed since 1946 and 1947, two years when infant mortality fell dramatically. These years witnessed a tremendous rise in the availability of new health technologies in the form of penicillin (used to treat infections) and DDT (used for malaria control). These advances were made by the extension of health care delivery throughout the country. By 1950, hospitals were treating 12.3 million patients a year, an increase of 61 percent over the last five years. The population readily accepted the expanded medical services and pregnant women,

instead of availing the services of local midwives, enthusiastically made regular seven-mile journeys to prenatal clinics and hospitals and gave birth under hygienic conditions. This led to a constant lowering of infant and maternal mortality rates in the country. Similarly, in Costa Rica, implementation of effective methods to finance public health care in remote, poor areas has helped to reduce general mortality and more specifically child mortality. China is another example where the extended health care system has played a major role in reducing mortality and morbidity. The development of a three-tier health care delivery system, which extends to the remotest part of the country and incorporates both traditional and modern methods of prevention and cure has led to the success of the system. In this connection the innovation of the "barefoot doctor" has helped further to increase the accessibility of the medical facilities among the common poor.

Access to modern medical facilities throughout a mother's pregnancy, at delivery and during infancy and childhood is thought to be particularly important in reducing mortality. The studies from Kerala and Sri Lanka demonstrate major mortality reductions, while both have persistent levels of morbidity. In Kerala, infant mortality has fallen by 2/3rds since 1956, but there has been no change in the prevalence of communicable diseases. The morbidity pattern is very similar to all of India, though the infant mortality rate is only 1/3rd that of the nation as a whole. Similarly, in Sri Lanka, there has also occurred a significant decrease in the infant mortality rate and overall death rate, but with a persistence of high morbidity, particularly of the diseases of poverty and undernutrition. The situation gives a clue to how clinical services do affect health levels; averting death where they can be effectively applied.

The Role of Distance on Health Conditions

The mere existence of medical facilities does not ensure improvements in health standards. Utilization of these facilities depends on various factors like the density of these facilities, quality of services, physical accessibility of services and the educational level of the people. Mass education is expected to increase the utilization of these services. Studies have shown that the utilization of health care units depends often on the physical proximity of these facilities. In a study done in Thailand, Entwisle et al. (1984) demonstrated how the availability of family planning outlets increases the likelihood of contraceptive use and enhanced desire for no more children, thereby reducing the fertility rate of the population. Trips for health services in developing countries demonstrate a distance decay function, which declines to zero within very short distances. This is mainly due to the lack of good transportation in the urban areas and almost no transportation in the rural areas. It is usually assumed that people in these areas are willing to travel a distance of 5 kilometers to a primary health center for preventive and minor curative services (Mehretu, Pigozzi, and Wittick 1983). Stock (1987) found a regular distance decay in the utilization of pharmacy facilities in Kano state, Nigeria, with an approximate 25 percent fall in utilization on average for each kilometer to the facility. It was also found that with increasing distance from the facility, there was greater competition from alternative sources of traditional care. Habib and Vaughan (1986) observed that the decline in utilization was slightly sharper for local health centers than for larger sources. About 10 kilometers from home, utilization rates of the nearest health center are only about a third of their level at 1 km. or less.

Fosu (1986) points out that about 70 percent of the attendance in a health center in Ghana were from within a 3 mile radius of the facility, although the residents of this area comprised only 23 percent of the health center's catchment area population. Only 27 percent of the patients came from beyond 4 miles, but 73 percent of the health center's catchment population lived at that distance. In a similar situation in Guatemala, Annis (1981) found that although the quality of service offered was more important than physical accessibility, those living further away used them much less. About 16 percent of the population studied lived 1 kilometer or less from a health post, such people accounted for over 50 percent of the patients. Conversely, half the population lived more than 3-5 Km. from a post but such people made up only 15 percent of the health post clientele.

Kroeger (1983) notes that accessibility in rural India was a dominant factor affecting use, although the strength of distance decay varied from one type of facility to another. A health center attracted 75 percent of its patients from within 2.9 miles, traditional practitioners 2.5 miles, and qualified allopathic practitioners had a larger catchment area of 7.5 miles. Long distances and waiting times were cited as major factors determining choice of treatment among therapies offered. In Indonesia, distance was a significant factor particularly for the rural people and the upper income group was able to travel more than twice the distance of the lower income group to reach a physician. It seems that as a result of this factor, fewer higher income people were reliant on self treatment or paramedical assistance. Utilization of health services in developing countries almost always involves an opportunity cost and this opportunity cost differs for the male and the female child. Based on these opportunity costs distance decay for

female children is most often steeper than the male child, often because of the high domestic work load for female children.

The Role of Gender

About 50.3 percent of the world's population was male in 1983 (UN 1991), amounting to about 101 males for every 100 females. The ratio between males and females varied from country to country, for example, there were 95 to 97 males for every 100 females in Europe, the US and Japan; 88 males per 100 females in the former Soviet Union, 99 males per 100 females in Africa and 105 males per 100 females in Asia (Coale 1991). The countries of South Asia show some of the most masculine gender ratios in the world (Coale 1991). Although undercounting of females is often considered as a factor in these populations, mortality rates are higher for females than for males in most age intervals from age 1 month to age 35-40, not merely because of some special gender related biomedical factors or undercounting, but for other reasons (Visaria 1969, 1995; Coale 1991). This disadvantage begins during the neonatal period and most of this gender differentiation in mortality is concentrated in the childhood years. In a global view, Waldron (1987) concludes that excess female mortality can be accounted for by two factors: relative contribution of specific causes of death (with different impacts by gender) and variability in discrimination by gender, primarily in nutrition and health care use.

Although impressive progress has been made in improving education and health for the population in general, in some states in India, particularly in the north, the mortality rates show that "female disadvantage" relative to males not only persists but also is worsening. David Sopher (1980) has drawn attention to regional disparities in sex

ratios and suggested that they are a derivative of the socio-cultural differences that characterize different parts of the country. He proposes a broad north-south dichotomy, with a line drawn around the Satpura hills in the center of the country, demarcating contrasting regions of cultural ethos and therefore of attitudes toward women and therefore contrasts in female life chances. Dyson and Moore (1983) have recognized a similar dichotomy with the south being generally favorable to the female, whereas the north is not. In her comparative study of people from Tamil Nadu and Uttar Pradesh, Basu (1992) found that during the neonatal period, girls had a relative advantage over boys in both populations. However, during the postneonatal phase, the two groups diverge greatly. In both cases, girls lose their earlier advantage but for Tamil Nadu, they now do the same or only slightly worse than the boys, while for Uttar Pradesh male survival rates leave female children far behind. In another study done in Madurai district of Tamil Nadu, Gunasekaran (1988) also found that girls experienced a lower neonatal mortality and a slightly higher postneonatal mortality than boys, but the differences were not statistically significant. Ramanujan (1988) found that female babies in rural Tamil Nadu do not suffer from any marked disadvantage with respect to mortality during infancy. In a study done in the state of Gujarat, Gandotra and Das (1988) found that male babies had a significantly higher risk of dying than female babies during the neonatal period, whereas female babies faced a significantly higher risk of dying than the male babies during the postneonatal period. Arnold (1998) found evidence of excess mortality for girls between the ages of 1 and 4 years. Girls in all the northern states experience higher mortality in general, and the excess mortality is more sever in families with more children. They attribute this difference to the relative difference in the status of women

and female autonomy. By the criteria provided by Basu (1989) and Dyson and Moore (1983), the position of women in northern India is notably poor. It is often suggested that the north and north western parts of the Indian sub-continent are an extension of the broad cultural region of West Asia, and the impact of Islamic culture was consolidated there over the centuries of Muslim rule. This allegedly, may have resulted in the lower status of women and the higher incidence of female child mortality (Bardhan 1974). Furthermore, a traditional Hindu society in northern rural areas is hierarchical and dominated by men, and its patrilineal, patrilocal structures have important implications for females. North Indian Hindus are expected to marry within the socially accepted boundaries of their castes; usually arranged by family elders. The bride groom must not be related, and the man must live outside the woman's natal village. "Wife-givers" are socially and ritually inferior to "wife-takers" necessitating the provision of a dowry. This arrangement influences the life of female children, who are generally considered more of a burden to their parents than sons because of the costs of losing a productive worker after marriage and the provision of dowry. Women generally do not inherit property for their own use, nor act as links through which major property rights are transferred to offsprings. North Indian brides are "strangers" in a strange place. The older females in the household control them, and their behavior reflects on the honor of their husbands and of the larger patrilineal group. Restrictions on their movement and interaction with men often amount to "purdah". Emotional ties between the spouses are allowed at a minimum, in order to maintain the solidarity of the patrilineal group. Due to limited communication between spouses, very little is discussed between them regarding their children's health or family planning. The primary duty of a newly married young

woman, and virtually her only means of improving her position in the hierarchy of her husband's household, is to bear sons.

On the other hand, south Indian men are more likely to marry women to whom they are related, either actually or nominally, so that the strict distinction found in the north between patrilineal and marital relatives is absent. Women are likely to be married into familiar households near their natal homes. Since there is no restriction on physical movements, southern women can maintain close ties with their natal kin, and affective ties between spouses is culturally accepted. The social distinction that prevails in the north between the families of the bride and the bridegroom is also absent. Southern marriages have typically involved a bride price (a sum of money agreed to as part of the marriage settlement) rather than a dowry traditional in the north, but any exchange of large sums of money or goods among close relatives is considered inappropriate in southern India. Although marriage patterns in southern India have changed through time and marriages between close relatives is becoming less common and dowry is replacing bride price, (Rao and Bloch 1993), southern marriages reinforce existing kinship ties thereby protecting the position of women in society.

Bardhan (1974) has offered an ecological explanation as a major factor in creating the "female disadvantage". According to him, all states in the east and south (except Karnataka) have a predominantly paddy (wet rice) based agricultural system, which unlike the dry wheat lands of the north tend to be relatively intensive in female labor. The cultivation of paddy requires women labor in transplanting, weeding, harvesting and other aspects of processing of the crop. On the other hand, dry wheat cultivation involves muscle power, provided by men and machines. This increases the relative importance of

women and improves the life chances of the "girl child" in the paddy cultivating areas. Bardhan further expresses that pastoral or nomadic production conditions in West Asia which affected the social mores of the north and north western part of the Indian subcontinent might be at the core of the subordination and lack of use of female labor.

Rosenzweig and Schultz (1982) have also put to test the hypothesis that differential survival chances of female children are related to the expected employment or earning opportunities of female adults. With data from 1334 rural households in India, a two stage regression analysis was applied to confirm that there is significant positive correlation between normal rainfall at the district level and the probability that a woman is employed in rural India, and that the differential survival chance of the female child improves with higher female employment rate or with a lower male-female earning differential per day.

Miller (1981) tried to construct a fascinating theory linking together agrarian ecology, the nature of property holding and the life chances of women. Her theoretical explanation focuses on cultural influences within a definite economic system. She hypothesizes that a mode of production in which females play an important role tends to be found in tandem with a system of inheritance granting females access to the major means of production, which in rural India is land. Conversely, a mode of production, which excludes females from productive roles, will coexist with inheritance rules that will also exclude females from access to major means of transportation. The lower the economic value of women, the greater the need for a compensating dowry. Thus the appropriation of dowry by the bridegroom's family corresponds to a cultural mechanism,

which maintains the subordination of women, and the high cost of a daughter's marriage is a major element in the peasant's attitude to the gender of offsprings.

In comparing the propertied and the unpropertied, dowry and marriage costs for the bride's family are usually higher among the former all over rural India, partly reflecting the lower female participation and the inheritance practices among the propertied. On these grounds one would expect a larger degree of relative neglect of female children in propertied classes in rural India. However, on the other hand, Rosenzweig - Schultz in their analysis found that an increase in household ownership of land assets is associated with a larger survival prospect for female children, holding constant for predicted female employment rate, indicating that neglect of female children is less likely to be fatal in richer households compared with the poor. Thus the differential chance of survival of a female child will depend on a variety of related and economically important factors, such as the wealth position of the household, its inheritance and marriage payment practice, and female employment prospects, apart from the educational and caste status of the household, the degree of prevalence of hypergamy (usually involving large dowries), and the process of Sanskritization (through which the lower castes try to upgrade themselves by adopting upper caste practices like dowry and work taboo for women).

Basu (1990, 1989) is of the opinion that cultural contrasts between the north and the south are so strong that they exist independently of regional socioeconomic differentials. She studied two groups of rural migrants from the north (Uttar Pradesh) and the south ((Tamil Nadu) of India, living in similar circumstances in a resettlement area in Delhi. The Tamil women exhibited far more autonomy than those from Uttar Pradesh.

About 64 percent of the Tamil women as compared to only 6 percent of those from Uttar Pradesh were employed outside the home. Their greater level of autonomy was reflected in the much higher level of interaction with the outside world that all of them, not just those who were employed, enjoyed in their day to day lives compared with the women from Uttar Pradesh. In terms of health care, this exposure to the world beyond their household not only increased their knowledge of available healthcare services but also gave the women the confidence to seek medical care. Both fertility and mortality levels were higher in the population of Uttar Pradesh. Among the Tamil group, however, the male mortality rate exceeded that for females.

Preference for Sons

In a region where the male child is a potential source of economic support while the female child is a net cost to the family, a strong preference for sons is inevitable. Son preference is also in the interest of the lineage, whose continuity depends on sons alone. In severe cases, this son preference results in infanticide and sex selective abortion. Although accurate data on these practices are not officially available, female infanticide has been documented in both northern and southern India. George, Abel and Miller (1992) found that female infanticide was practiced in 6 out of 12 of their study villages in the south Arcot district of Tamil Nadu. In these villages, 10 percent of newborn girls were not allowed to survive. The study also suggests that infanticide is related to social status (caste), the number of living daughters, educational levels and geographic location. Determination of the gender of a fetus has been made possible by the use of medical techniques such as amniocentesis and ultrasound. A review of 1981-91 data indicates that sex selective female abortions amounted to almost 1 percent of actual female births

in India, which is very high when the actual number of births in the whole country is taken into account.

The preference for sons is readily apparent in differential treatment that leads to a higher mortality rate for girls, particularly those born into families that already have a daughter. In a study of Ludhiana district of Punjab, Das Gupta (1987) found that among the first born children ages 0-4, death rate was higher for males. However, this ratio is dramatically reversed for younger female siblings. For second children, female death rate was higher than for male children, and with each successive birth, the male female ratio declined further. When parents already have a living girl, a second female was more likely not to survive than a female born to a family whose first born child is male. In studying the demographic effects of family composition, Arnold, Choe, and Roy (1998) found that the gender composition of a family affects fertility behavior in every state examined and son preference is the predominant influence in all but one of these states. The effects of family composition on excess child mortality for girls are more complex, but girls with older sisters are often subject to the highest risk of mortality.

Domestic Inequities

Disparities in Food Distribution

There is a good deal of evidence from all over the world that food is often distributed very unequally within the family – with a distinct gender bias (against the female) and also an age bias (against the children). Such biases have been observed even in the richer countries (Ritchie 1963), but this discrimination is much sharper and more widespread in the poorer Third World economies (Mathur et al. 1961; D'Souza and Chen 1980). The Institute of Nutrition and Food Sciences of the University of Dhaka,

Bangladesh, did a sample survey during 1975-76 of 60 households each from 12 locations in rural areas. Chen, Huq and D'Souza (1980) also did a study, in 1978, of the intra family food allocation in 135 families residing in 4 villages in Matlab Thana in Bangladesh. Both studies found that in every age group, the female consumed fewer calories and less protein than the male members, with an overall shortfall of 117 percent in each of these two nutrients. In the Ludhiana district of Punjab state, India, Dasgupta (1987) found that although infant boys and girls have roughly similar caloric intake, girls are given more cereals, while boys are given more milk and fats with their cereal. It is not clear how much excess female mortality could be caused by this, but it is certainly the case that milk and fats are the highly valued and high cost foods of this society. Furthermore, she also found that on days when children aged 0-1 year ate partly at home and partly outside, there was little difference in male female consumption of cereals and sugars at home, but girls received much less milk at home than boys and very little fat. She is of the opinion that efforts are made to ensure that boys get their usual amounts of milk and fats within the household even if they are away for some of the day, while girls are allowed to go without. Once again, this could have some nutritional effect on girls but in any case suggests that girls aged 0-1 year receive less care than boys. The Narangwal study (Kielman et al. 1983) done in the same district of Punjab suggests similar gender disparities in the allocation of food. Studies in Uttar Pradesh (Khan et al. 1989), Andhra Pradesh (Bidinger, Nag, and Babu 1986) and Tamil Nadu (Devdas and Kamalanathan 1985) all indicate that female children are discriminated against when it comes to the allocation of food within the household. It was also found that female children are likely to be breast fed less often and for a shorter period of time than her

male siblings and to be weaned sooner (IIPS 1994; Khan et al.1989; McNeill 1984; Kumar and Dutta 1983; Das, Dhanoa and Cowain 1982; Levinson 1974). Population based surveys suggest that male and female children are breast fed for 25.3 and 23.6 months, respectively (IIPS 1995).

However, in another study, Basu (1989) found that severe malnutrition was more prevalent among boys than among girls in a sample of children from Uttar Pradesh now living in Delhi, while the converse was true for the Tamil Nadu sample. In spite of this however, the mortality of girls from Uttar Pradesh was higher not just than boys, but also than that of the Tamil children of either gender. The malnutrition mortality link is somewhat ambiguous in most studies in which the impact of nutritional interventions on mortality is examined. Although intuitively it seems obvious that more severe malnutrition should mean more deaths, due to increased incidences of infection, studies have shown little association between malnutrition and frequency of illness (Chen at al. 1981; Martorell and Ho 1984; Kielman et al. 1983). These studies show that except in a limited number of cases, changes in mortality cannot really be explained by secular changes or cross-sectional differences in nutritional levels.

Disparities in Health Care Usage

It is increasingly being recognized that differences in health care may be more significant than differences in nutritional status in determining the gender disparity in young child mortality (IIPS 1995; Basu 1989). There is considerable evidence that male children receive more and better health care than female children do.

In the Khanna study of 11 villages in Ludhiana district, Punjab, there is evidence of differential medical treatment of male and female children (Singh, Gordon and Wyon

1965). An investigation of medical attendance during all fatal illness in this area suggests that overall death rate was 19.6 per 1000 for females and 14.8 for males. Fewer females than males had medical care during the fatal illness, and females generally received care from attendants at a lower level of competence. The Khanna 1985-86 data suggest that relative female deprivation in medical care may be more important than is nutrition in accounting for gender differentials in mortality. Two decades later, Dasgupta (1987) found that the situation had not changed. She found that more than twice as much was spent on boys as on girls in the age group 0 – 1 year. A hospital study in Ludhiana district of Punjab concluded that gender bias prevented 3 out of 4 girls who were ill enough to require hospitalization from receiving the care they needed (Booth and Verma 1992). In their study of Matlab area in Bangladesh, Chen at al. (1981) found that in spite of the provision of free treatment for diarrheal diseases and the nearly comparable incidence levels of field diarrhea, male children under age 5 years were brought to the Matlab treatment facility by their guardians far more frequently than female children. Diarrheal treatment rates averaged 135.6 per 1000 among male children in comparison to 81.9 among female children, the former being 66 percent higher than the latter. It is interesting to note that the ICDDR, Bangladesh diarrheal treatment services are free, and travel to and from the facility is provided without charge in jeeps and speedboat ambulances. Thus, the incremental financial cost in the utilization of these services is marginal. Of course, the time and indirect costs may be considerable. It would be interesting to see how distance from the center affected utilization rates.

Caldwell, Reddy and Caldwell (1983) found that in rural Karnataka, twice as many boys as girls were brought to the primary health center. And in a study of one rural

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area in Western Uttar Pradesh, Khan et al. (1989) reported that over a one-week period roughly three times as many boys as girls were brought to the primary health center. Recent state level reports for Uttar Pradesh (IIPS 1994) confirm these earlier findings. More male than female children are fully immunized (23 and 17 percent respectively). 73 percent of male children, compared with 62 percent of female children, were taken to a health care provider or health facility in the event of an acute respiratory infection. For India overall, in 1992-93, more boys than girls were vaccinated and treated for acute respiratory infections and fever (IIPS 1995).

In a cross-sectional survey of 3100 families in 45 contiguous villages in the Pune district of Maharashtra in 1991, Ganatra and Hirve (1994) found that a significantly higher percent of boys were treated by a registered private practitioner during an episode of diarrhea. This difference persisted even after adjusting for severity of the illness. Referral action was taken by parents more in case of sons (69.2 percent) than daughters (25 percent). Families spent more money on the treatment of sons than on daughters. This difference was significant even after controlling for the type and severity of the illness. In 11 percent of the female children and 3.3 percent of the male children, only the free health care facilities and services were utilized and no money was spent on medicines, transportation or consultations. Boys were also favored when one had to travel a greater distance to seek medical care treatment. Thus, for a significantly higher proportion of girls medical advice was sought only within a 2 Km radius (i.e., within the village itself). The proportion was higher for boys when the distance to travel was more than 2 Km. Logistic regression analysis showed that after controlling for severity and other type of illness and other factors like parents' education, occupation and income, the

chance of seeking medical advice from a private practitioner was 2.5 times greater for boys than for girls. Sons were also favored, compared with daughters, by parents who were twice as likely to travel outside the village for medical care and about 3.7 times likely to spend more for treatment. If referral for further treatment was advised it was 6.8 times more likely to be availed of in the case of a son, compared to a daughter.

Under such circumstances where the treatment of boys is considered much more important, it can be expected that the farther the health facility, the more unlikely it will be for the girl to be treated. This may lead to an increase in the differential between male and female infant mortality. However, no study has been done to look into the relationship between gender differentials in infant mortality and distance from a health center.

The Role of Household Income

The potential role of income related factors in infant and child survival is complex, mainly due to the multifaceted nature of income itself (UN 1985; Schultz 1984). Many different concepts of income can be used such as household income, household real income, and household full income. The relatively few studies focusing on the relation between infant mortality and household income in developing countries found a consistently negative association.

Carjaval and Burgess (1978) used data from the Urban Fertility study done in Bogota, Caracas and Rio de Janeiro. The five independent variables in their ordinary least squares model were household income, mother's education, mother's labor force participation, migration and incidence of consensual unions. Taking the number of child deaths reported by each mother in a certain group as dependent variable, regression

coefficients turned out to be negative and significant at the 10 percent probability level for all age groups at Bogota and even more significant at Caracas and Rio.

Schultz (1979) developed an economic model which takes the ratio of number of children dead to the number of children born alive as a function of market wage offers to the mother and her husband, assets in the physical wealth of the mother's household, market and time prices facing the household, public health input in the region of residence per potential recipient, the region's physical health environment and lastly paternal and maternal education attainment. He cross-classified income elasticities by age of mother and rural or urban residence and showed that income elasticities in respect of infant mortality are significantly higher for educated women than for the uneducated, which supports the expectation that education tends to increase the efficiency of income allocated for health. The other significant pattern that has appeared in this study is that of higher income elasticities in urban areas than in rural areas after controlling for education and age. It is not clear, however, whether this pattern is a real effect or results from more accurate measurement of income in urban areas.

Another study (Rosenzweig and Schultz 1982) examined how intra-family resource allocations respond to changes in economic conditions and to genetic differences in children by estimating the determinants of variations in the gender- specific survival differentials among rural Indian children, based on standard census and household survey data. Although this study does not directly focus on the question of the effects of household income on child mortality, its findings appear to be relevant for the understanding of that process. This study finds that increases in wealth, in terms of land ownership or other productive capital asset, are associated with greater female

improvements in survival prospects, which in consequence will lead to lower child mortality levels.

Anker and Knowles (1980) studied mortality determinants using household level data from the 1969 Kenyan census. Only women aged 20 – 29 years were selected for the multiple logit regression analysis using dichotomous dependent variable (whether a child survived to age 3). The independent variables ranged from the form of water supply and lavatory facilities, gender, income (the measure of household income per equivalent adult per annum), education and year of birth to whether the area of residence is malarial. In this study the correlation coefficient for income was positive and significant. However, this significance is not surprising because, other than a crude measure for education, income was the only socio-economic variable in that equation.

In a study done by the UN, multiple regressions were done on data for the three countries of Nigeria, Sri Lanka, and Thailand. The reference category was the highest income group for each country. The expected inverse relationship between income and child mortality is clearly seen only for the mother's income in Nigeria. For the father's income in Nigeria and Sri Lanka, results seem to suggest that there are some thresholds. In these countries mortality drops sharply up to a threshold beyond, which no substantial decline in child mortality with income, is observed. Thailand shows a rather puzzling U-shaped pattern; the lowest and the highest income categories exhibit higher mortality and the two intermediate income categories are associated with lower mortality. In this same study, number of goods owned by the household showed a strong negative relationship with child mortality in the countries of Korea and Sierra Leone.

The estimation of the relation between income and infant/child mortality is an extremely difficult task. First, income is expected to serve as an indicator of children's consumption of goods and services that affect their health including calories and nutrients, clothing and shelter, sanitary facilities and the use of medical facilities. However, none of the data sets contain any information on these matters. Moreover income may not be a valid indicator of consumption, when relative prices of those items are very different from the relative importance of the items for increasing child survival. Secondly, measurements of income are diverse. Thirdly, the power structure within the family and roles and status of its members are important components of child survival, because children do not allocate resources to themselves and have to depend upon resources allocated to them by adults in the family. Lastly, several of the data sets contain information on a household's level of wealth, mainly in the form of a stock of assets of a particular type. Although wealth is closely related to income, it might not lead to increased consumption, since wealth is created out of income, in particular, by reducing the level of consumption below the level of income. It is clear that wealth is, in general, a less satisfactory indicator of consumption than is income. Finally, it is important to distinguish between net and gross income. However, none of the surveys provide any information on household debt, thereby creating a limitation faced by almost all studies in India and other developing countries.

The Role of Residential Characteristics

The characteristics of the dwelling place have long been recognized as an important influence on infant and child mortality. The majority of relevant studies of the impact of housing conditions on mortality have focused on the presence and type of

lavatory facilities, the power source and the type of building materials used to construct the house. Harrington's (1974) study of West African societies views a child's chance of survival as the outcome of a series of factors governing exposure to disease and those encompassing the course and outcome of disease. These factors can be summarized as exposure and resource variables, the former group including environmental and socioeconomic elements and the latter containing such components as nutritional status and access to medical care. The type of dwelling affects mortality mainly through the elements of exposure. In addition to Harrington's study of Western Africa, similar approaches are employed in many studies of infant and child mortality in developing countries (Gordon et al. 1967; Roberts 1973; Frenzen and Hogan 1982; WHO 1974, 1978). Benjamin (1965) contends that the most important effects of housing conditions on health work through their impact on the incidence of infectious diseases; in particular diarrheal diseases, which he found to be relevant in England and Wales during the late 18th and 19th centuries. With an increase in population and crowding, rooms are being used for both day to day living and sleeping and often more than one family share sanitary facilities leading to an increase in morbidity and mortality. Kunitz (1986) also found that highly infectious diseases like smallpox were more easily transmitted in overcrowded living conditions. These situations in eighteenth and nineteenth century Europe are very similar to the average living conditions of the people in the developing world and pose the same threats to infant and child survival in these countries.

In a study done in Brazil, Merrick (1983) analyses the impact of availability of piped water on child mortality in Brazil. Access to piped water in the household is associated with the reduction in mortality of approximately 20 percent. Similarly,

Feachem (1981) points out that, of the infectious diseases related to water supply and sanitation, diarrheal diseases are of greatest importance. Rowland (1979) argues that the transmission of infectious diseases in Africa through a polluted water supply or unsanitary toilet contributed to the contamination of traditional weaning foods. This argument is supported by the findings of Butz and his colleagues (1982), in Malaysia, that breast feeding has a larger protective effect on infant mortality in areas where sanitary facilities are poorer.

In his study of neonatal mortality in Sri Lanka, Meegama (1980) examines deaths per 1000 live births by type of lavatory facility in the dwelling. The lowest mortality as expected, is associated with the presence of a flush toilet system and the highest with the absence of any system. Expanding his analysis to include two-and three- way cross classifications of sanitary facilities with father's education and mother's literacy, he finds toilet facilities to have the most important impact on neonatal mortality. This strong association of toilet type with risk of neonatal death is interesting and surprising in view of the fact that neonatal deaths largely depend on events in the uterus and at birth. It may be that toilet type is correlated with causal variables not included in Meegama's analysis. For example, Meegama points out that husband's education may not be a good proxy for economic status in Sri Lanka because there is a surplus of educated people in comparison to job opportunities. What is required is an analysis of the effect of toilet type on neonatal mortality with various measures of economic status held constant. But Meegama's data set does not permit that.

Applying more sophisticated analytical techniques to the same set, Trussel and Hammerslough examined the association of mortality up to 10 years of age with each of

maternal education, paternal education, maternal age at birth, gender of child, birth order of child, time period of birth, place of residence, ethnicity, toilet type and water supply, while controlling for the effect of other variables. While water supply was found to be not significantly associated with the risk of death in the first 10 years of life, better toilet facilities were significantly associated with risk of death in the first 10 years life. Unfortunately, the interaction effects of toilet type with paternal education are not shown in Trussel's paper. Although the statistical associations between better sanitation and reduced risk of death are strong, socioeconomic status is not adequately controlled. The apparent effect of sanitation could be due in whole or in part to wealth effects that might act on mortality via paths that either do not include sanitation or for which sanitation is a necessary but not sufficient condition.

In an ecological study of Sri Lanka, only types of dwelling variables were used in an attempt to explain regional variation in the infant mortality rate (Patel 1981). This study regressed the percentage of households in each district of Sri Lanka having certain basic utilities against the infant mortality rate. A stepwise regression procedure showed that a supply of well water, the presence of toilets and the presence of asbestos or tiled roofs explained 76 percent of the regional variation in the dependent variable. A similar study of the determinants of child mortality in Sudan included variables reflecting the type of household structure. The results show that living in a house made of mud raises child mortality by a significant 6 percent in the capital city and by 7 percent in all of Sudan (Farah and Preston 1982).

Using data from 6 countries, a study done by the UN (1985) found that, in general, old housing, deficient sanitary conditions, and lack of electricity constitute risk

factors for child survival. However, when the effects of several socioeconomic characteristics are controlled, this association weakens and remains present only in some of the cases studied. It has also been suggested that behavioral factors, mainly personal hygiene and health practices are perhaps more important considerations than the physical environment of the household. Variables related to the type of dwelling have not always been found to be closely related to child mortality. Using regional data from Bangladesh, Costa Rica, Mexico and Puerto Rico, Sloan (1971) found that sanitation variables and other measures of the quality of housing explained very little variation in mortality rates, and thus concluded that there is little proof of a causal relationship. The variables found to have the most important effect on mortality among young children were mother's literacy and nutrition (Sloan 1971).

Chen (1985) attributes considerable importance to the advances made in water supply and sanitation in China. She states that 38 percent of the rural population were served by improved (piped) drinking water supplies in 1982 and that water supply projects have been responsible for substantial reductions in the incidence of enteric diseases in some areas. In his paper, Rosero (1985) correlates infant mortality rate by country against several measures of socioeconomic status, health care, water supply or sanitation. In an uncontrolled analysis, the percentage of households with improved water supply or sanitation is correlated with infant mortality rates. When the other variables are controlled, the correlation of water supply and sanitation with infant mortality rate looses significance, suggesting that these environmental factors were not independent determinants of infant mortality in the period prior to 1970. In a second analysis, the decrease in infant mortality rate during 1970-80 by country is correlated

with the changes in socioeconomic and water supply variables over the same period. The uncontrolled correlation with increase in water supply is weak. In a multivariate analysis, increase in an index of primary care is strongly correlated with infant mortality decline. The index is made up by the coverage by the rural and community health program, vaccinations, community participation and water supply coverage, but this water supply coverage appears to make a relatively minor contribution to the explanatory power of the index.

Haines and Avery (1982) have analyzed possible determinants of infant and child mortality during 1968-73 on both a country level and a family level using a data sample from the census of 1963 and 1973 in Costa Rica. In a country level analysis, the dependent variable was the probability of dying before 24 months during 1968 – 73, and the independent variables were measures of fertility rate, urbanization, maternal education, attended births, sanitation (flush toilet), income and altitude. In an uncontrolled bivariate analysis, sanitation was significantly correlated with child mortality, but this correlation lost significance when the other independent variables were controlled. In the family level analysis, the dependent variable was the ratio of actual child deaths (0-23 months) to expected child deaths for each mother. Sanitation was categorized as good, fair and poor. In this study fair sanitation had an independent effect on mortality. For instance moving from a home with fair sanitation to one with good sanitation would reduce the predicted mortality index by 6 – 22 percent.

In a study done by Nag (1985) differences in water supply, especially the use of streams rather than tanks and the practice of drinking boiled water, were found to explain a small part of the mortality differential between the states of Kerala and West Bengal in

India. Panikar and Soman (1984) have suggested that water supply coverage is low in Kerala by Indian standards, while Krishnan (1985) points out that morbidity rates and patterns in Kerala are similar to those elsewhere in India, suggesting that mortality reductions have been achieved by better provision and utilization of medical care than by preventive measures such as water supply and sanitation.

Zachariah and Patel (1982) conducted a study on 3000 randomly selected households in 150 villages in 3 districts of Kerala in 1980. Data were collected on 9400 births between 1950 and 1980 to ever-married women. Multivariate analysis were undertaken with the following independent variables: maternal education, caste, single or twin birth, year or month of birth, birth order, per capita or total household expenditure, land ownership, water supply, and sanitation. For risk of neonatal and infant mortality, neither water supply nor sanitation showed an independent effect. For child mortality, however, both water supply and sanitation showed an independent effect. These results suggest that water supply and sanitation become important factors in Kerala when the child is at least partially weaned and is becoming increasingly mobile and so is more vulnerable to the risks of an unsanitary environment.

Several studies are based on a general presumption that rural-urban residence distinguishes sufficiently and clearly between poor and good conditions of sanitation, drinking water and housing structure (Mott 1979; Caldwell 1979). In Caldwell's study using Nigerian data, the distinction is between newer and older Ibadan, which makes the generalization less sweeping.

The role of dwelling type merits much closer attention. None of the studies have included housing characteristics like flooring material, distance from source of drinking

water or presence of animals in the household. In the tropical monsoon climate of India, infectious diseases like diarrhea, common cold and pneumonia often strike due to unfinished unhealthy flooring material. The presence of animals within the confines of the home leads to diseases caused by cattle litter. Tetanus is a major cause of infant and fetal death in India and can be more common under these conditions. Distance from the source of drinking water is important because greater distance can lead to storage of water, often in vessels that are not regularly cleaned, thereby leading to spoiling and infection.

The Role of Demographic Factors

Infant and child mortality is dependent on the demographic characteristics of the mother and the child. Four demographic factors have been found to be particularly important predictors of child survival. These include gender, maternal age and parity, and birth intervals and as several studies from the World Fertility Survey (WFS) have shown, all four have independent and synergistic effects on pregnancy outcome and child survival. The following sections elaborate the impact of all demographic variables except gender. Due to the special significance of gender in this research, its impact has been elaborated in a separate section early on in the review.

Maternal Age and Parity

In countries with reliable vital registration, infant mortality is known to vary according to mother's age at the time of birth, regardless of overall level of risk in the community. The relation tends to be "J" or "U" shaped, with mortality high for children of teen-aged mothers, relatively low for those in their twenties and then rising steeply with increasing maternal age. As a rule the WFS found the minimal age of risk to be

between 20 and 29 years. However, no single pattern could be identified and in a few countries, notably Syria, Sri Lanka and Malaysia, the period of minimal risk occurred between ages 30 and 39 years. Most countries showed extremely high death rates for the infants of mothers aged 40 years and above. In a study done in India, Basu (1992) found that there is a clear drop in the percentage of women who have lost a child as the mother's age at first live birth increases. For Uttar Pradesh, for instance, 69 percent of the women who had their first live birth before the age of 15 years had experienced some child loss. This percentage fell to 50 percent and 44 percent for women whose first delivery occurred at 18 -19 years and 22 – 24 years respectively. However, the Uttar Pradesh sample does not conform the "U" shaped relationship between maternal age at the time of birth and child survival status found for the 29 WFS countries. As expected, mortality falls with initial rises in mother's age and continues to fall even when the mother's age at delivery rises to enter the high risk ages above 30 and even 35 years (Basu 1992). This can perhaps be attributed to 3 factors. They are: the ability to raise a child with rising age, because of improved knowledge about child care, more time and resources available for a child born at a later stage of the household life cycle and the greater potential for help from older siblings. With child bearing starting at the age of 18 years, the typical infant with a 35-year-old mother will not lack in older siblings to act as a mother substitute. This same study found a more traditionally accepted "U"- shaped curve for child survival by mother's age at birth for Tamil children. However, the results are more interesting when mortality is disaggregated by age. Infant mortality initially falls with rising age at delivery and then begins to rise again for mothers over the age of 35 years. But mortality in early childhood (between 1 – 4 years) actually rises with

maternal age at delivery. This has been mainly attributed to the fact that the older the Tamil woman, the greater the chance that she is employed outside the home. In most cases the practice seems to be for women to spend the first few years of married life at home and then seek work.

In most WFS countries, birth order or parity also proved to be an important correlate of infant mortality. In high mortality countries, such as Nepal and Kenya, first born children were at a greater risk of dying during infancy than were their younger siblings, although there is a tendency for risks to increase again at birth orders seven or above. However, this U-shaped pattern was not observed in all countries. In countries in which overall mortality was lower, such as the Phillipines and Jamaica, the first born were the most likely to survive, thereafter risks of death increased progressively with birth order.

In virtually every country in the WFS, "toddler" mortality increased with birth order. The only exception was Senegal where the risk for first born one year olds exceeded that of the second or third order births by more than 5 deaths per 1000.

More research has shown that there is an interaction between birth order and maternal age, such that the risk of death to children of mothers of the same age varies with birth order. Infants most at risk tend to be high birth order children of very young mothers and low birth order children (in particular the first born) of relatively older mothers. This interaction may account, at least partly, for the absence of a completely uniform pattern in the relation between risks of child death on the one hand, and maternal age or birth order, on the other. In her study in India, Basu (1992) found that amongst women of Uttar Pradesh the effect of parity is similar in case of infants and young

children. However, in Tamil Nadu, the risk of dying in infancy is 1.2 times greater for children born to mothers with a total of 4 – 6 as opposed to 1 – 3 live births, while it is 3.8 times greater for children between 1-4 years and within similar fertility categories. This is perhaps because deaths in the 1 – 4 age group is more a function of child care quality rather than maternal depletion caused by several pregnancies.

Birth Intervals

Recent research has shown that birth interval is one of the most important demographic factors affecting child survival. The impact of birth interval is important in case of the child preceding and the one succeeding the index child. Much of the evidence for this relationship was provided by the WFS (WFS 1978). Analysis of the Kenyan Fertility Survey has shown that the higher neonatal and postneonatal mortality rates are found for children born after a birth interval of less than 2 years. This may be attributed to maternal depletion. The impact is essentially strong among those born following an interval of less than one year. These children suffered an infant mortality rate of 250, twice that of children who follow an interval of 12–23 months. With an interval of 24-36 months, the infant mortality rate was observed to be only 68. These differences persisted after adjusting for the effects of a number of variables such as parents' education, mother's occupation and religion. The excess risk continued past the first year of life (Ewbanks 1983). In their study in rural Guatemala, Delgado et al. (1986) found that both neonatal and postneonatal mortality was higher when the time since the previous birth was less than 18 months. Infant mortality rates were also particularly high among those born after an interval of more than 36 months. In a study done in a slum in Bombay, India, Basu (1992) found a negative association between infant and child mortality and

the length of the succeeding as well as preceding birth interval. This study also pointed to the effect of sibling competition in addition to the effect of maternal depletion due to frequent births. Maternal depletion is thought to be the major proximate determinant of infant mortality due to frequency of births. On the other hand, sibling competition is significant during the ages of 1-4 years. However, the relation between birth spacing and infant child mortality is often made spurious by other factors. For example, Miller (1989) found that prematurity was a major confounding factor in increasing perinatal mortality among closely spaced children in Hungary and Sweden. Furthermore, women with short birth intervals may also be those with the worst childcare behavior, due to social or economic reasons. In such a situation, it would be difficult to separate the impact of child spacing and social and economic conditions leading to improper child care behavior.

The Role of Socioeconomic Factors

Education

Studies have suggested that infant/child mortality in developing countries is associated more closely with maternal education than any other socioeconomic factor (Behm 1979; Caldwell 1979; Cochrane et al. 1980). Most survey and census analyses have revealed marked differences between the survival chances of the children of educated mothers and those of mothers with little or no education. Gaisie (1969) employed data from the 1960 census of Ghana to show great differences and to demonstrate that mothers with similar education experienced similar levels of child mortality whether in urban or in rural areas. This reverse relationship between mother's education and child mortality was also shown to be true for eight Latin American

countries which held censuses during the first half of the 1970s in an analysis carried out by Behm (1983).

In most instances, more educated women in developing countries are more likely to marry men with higher education and incomes and also earn more themselves thereby improving the general socioeconomic condition of the household where the child is born. Nevertheless, education might be more than a proxy for income and might have a distinct, separate impact. Orubuloye and Caldwell (1975) reported that women of similar economic standing in Nigeria were characterized by child mortality differentials by education not only in a community with modern health services but also in one without such services. This problem was investigated further both in the city of Ibadan and more widely in southwest Nigeria as part of the Nigerian segment of the African Family Project (Caldwell 1979). Child survival was analyzed in terms of the education of each parent, their type of marriage, their socioeconomic status, their practice of birth control and their urban-rural residence. The single most important influence on child survival was found to be the level of maternal education, although that of paternal education was also significant. Farah and Preston (1982) employed data from the Sudan segment of the changing African Family Project to show that parental education, especially that of the mother, played an equally dominant role in Greater Khartoum.

In 1981, Caldwell & McDonald were able to present analyses from the World Fertility Surveys in Asia, Latin America and Africa to show that for most countries maternal education had a stronger influence than paternal education and that both were more significant than income level. Hobcraft, McDonald & Rutstein (1984) have employed data from WFS projects in 28 countries. In their more complex analysis, the

general picture remained unchanged. They analyzed child survival in terms of mother's education, father's education, mother's work status, husband's occupation and rural and urban residence. When selecting the 3 factors for a model that would best describe child mortality, maternal education was definitely omitted in only 3 of the 28 cases: Jamaica (where the explanation may be the general high level of female education), and Nepal and Pakistan (with very low levels of female education).

Education tends to impact infant/child mortality in 2 ways. It facilitates knowledge and usage of available health care facilities. In this case education and health care are complementary. Secondly, education could fill the gap created by the lack of medical facilities by providing information on health and personal hygiene (Rosenzweig and Schultz 1981). Above all, education enhances a mother's ability to provide adequate childcare by challenging her traditional notions of disease and by altering familial relationships. An educated mother can be expected to be less fatalistic, better able to deal with the modern world and more aware of simple hygienic measures. In their examination of Bangladeshi villagers, Lindenbaum et al. (1983) found that in a society where the position of women differs markedly from that of men, an educated woman had a higher status within both her family and her husband's family. They were more autonomous and more capable of taking advantage of modern medicine and health facilities. The link between education and birth weight of offspring may also arise from the mother's receiving better care and more adequate food during pregnancy. Rejecting taboos, the woman may be more inclined to eat high protein foods such as chicken and eggs, which are often prohibited during pregnancy in traditional societies (Ware 1984).

The importance of the link between a woman's education level and the survival of her female children cannot be overemphasized. Studies in developing countries in general, and India in particular, have consistently documented a strong relationship between mother's education and her children's survival. The more educated a mother is, the more likely it is that her husband and in- laws will allow her to decide whether and when to seek medical care for her sick children. Educated mothers are more likely to seek care earlier in an episode of illness and to choose modern over traditional medicine. Furthermore, the evidence indicates that educated mothers are more likely to continue with recommended treatments and to return to the nurse or doctor if the problem persists, rather than try an alternative method. Education can also change the social mores regarding the seclusion of women and girls which often result in a reluctance to have women and girls examined by an outsider such as a doctor, particularly if he is male.

Education can also lead to a rise in women's employment. Rosenzweig and Schultz (1982) found a negative correlation (in a district level analysis) between female employment rates and male/female differential in survival. Several others with cross-sectional (Miller 1981; Bardhan 1974) as well as longitudinal data have drawn similar conclusions. Wadley (1989) for example, speculates that declining opportunities for female employment have led to increases in gender differentials in mortality in poor households in Uttar Pradesh, India. High female labor force participation rates are associated with greater gender equality in child survival (Basu and Basu 1991). This is because where economic productivity of women is low, this is matched by a smaller demand for daughters. Not only do areas with high female labor force participation rates exhibit greater gender equality; even in areas of low labor force participation by women,

working women experience less gender biased child loss. This suggests that it does not take long for the value of women's productive work to be perceived as a reason to rear daughters that live a long life.

Bourne and Walker (1991) found a shift in the gender differential in mortality with increasing age. Their study in India verified the effect of mother's education throughout the first 5 years of childhood. Although in infancy, it is of greater importance for boys, in subsequent years, its largest effect is on girls, especially in the northern part of the country. Bhuiya and Streatfield (1991) in their study in Bangladesh indicated the positive effect of mother's education on child survival between the ages of 6 and 35 months, when the effects of other variables are held constant. However, conflicting results were obtained in Dasgupta's study of birth order and excess daughter mortality in some villages in the Ludhiana district of Punjab, India. She found that girls born to women with some education to be at a greater risk of dying (relative to boys) than those born to women with no education.

Most studies that have analyzed child mortality differentials according to parental education have focused on the mother's education rather than the father's education. In most developing societies, the gender division of labor and predominant gender roles discourage men from taking day-to-day child care duties, resulting in a system where the time and effort devoted to child care is greater for women than for men. Furthermore, due to limited job opportunities in local areas, many men in developing countries are forced to seek employment elsewhere, leaving their wives to shoulder the entire burden of childcare. Based on these premises, the literature has treated paternal education more as a predictor of economic status than as an indicator of quality of child rearing skills.

Although paternal education is thought to operate primarily as a proxy for level of living, it may also affect other aspects of a family's life such as beliefs about the origin and cure of diseases. For example, the educated father, although perhaps not directly responsible for childcare, might initiate changes in the family's personal hygiene and food preparation procedures.

Both Cochrane et al. (1980) and Caldwell & McDonald (1981) have documented the greater importance of mother's education. Based on several national studies, it has been estimated that for every additional year of maternal schooling, the child mortality rate falls by approximately 6 per 1000, whereas for every year of paternal schooling, it is reduced by 3 per 1000 (Cochrane et al. 1982). However, certain other studies that control for more variables, have found that the impact of paternal education is as large as, or larger than, that of maternal education (Hammerslough and Trussel 1983; Martin 1983 Trussel and Preston 1982). The role of paternal education appeared to be particularly important in Sri Lanka. One cross-national study has identified a regional pattern with regard to the two education variables, finding that families with the least educated husbands have the highest rates of child mortality in Asia, while families with the least educated wives have the highest rates in Latin America and the Caribbean. The explanation given for this regional difference is that, where education of women is relatively common as in Latin America and the Caribbean, selectivity factors make the "no education" group particularly susceptible to high levels of child mortality (Hobcraft et al. 1984).

Studies have also been done to identify the mechanisms through which schooling of the father acts to reduce child mortality. By observing changes in the paternal

education variable as other variables are incorporated into the regression models, tentative conclusions have been drawn. Both Schultz (1979) for Colombia and Farah and Preston (1982) for Sudan found that inclusion of father's income did not make the effect of father's education insignificant. Either monthly wages do not accurately reflect permanent income, which Schultz believes is the case for Colombia, or paternal education, at least in the two countries examined, does not operate on mortality solely through market channels. Farah & Preston (1982) suggest that father's education, like mother's education, has an important "direct" effect because education imparts knowledge about health and undermines traditions that are associated with higher child mortality. Schultz (1979) investigated whether the effect of father's education differed in rural and urban settings. Presumably, if father's education does work indirectly through economic variables, its impact should be greater in cities, because the income returns from education are greater in urban areas. Schultz found that when income was not included in the model, the education coefficient for fathers was considerably larger in urban areas, but so was that for mothers. This finding was inconsistent with the notion that father's education alone works through market channels. When education, region, income, and a measure of experience are considered together, the coefficient for the father's education is greater in rural areas than in urban areas and the impact of income on mortality is greater in urban areas. This suggests that there may be a non-market component in the parental-schooling effect, which is of greater importance in rural areas, where the market value of education is low.

Occupation

Almost all the studies that use occupation as an indicator of socioeconomic status employ five or fewer occupational categories (Meegama 1980, is an exception). These studies typically find the father's occupation to have a significant effect on mortality but to become insignificant when other socioeconomic variables are introduced.

Examples of studies showing significant effects of paternal occupation in the absence of controls on other socioeconomic variables are Gupta and Rao (1976) in rural Allahabad, India, Hogan and Jivani (1973) in Tanzania, Behm (1983) in Costa Rica, and Taucher (1978) in Chile. Taucher further reports that a large educational gradient exists within occupational groupings. Farah & Preston (1982) eliminate the significant influence of father's occupation in the Sudan by introducing controls on parents' education and income, and Trussel & Preston (1982) find insignificant effects on the father's occupation in a multivariate analysis in the Republic of Korea and Sri Lanka. Frenzen & Hogan (1982) find that parental occupation remains significant in a multivariate analysis of a rural Thai sample; however, this is the only study that does not include father's education. Furthermore, the authors caution against extensive generalization because their sample was quite small, consisting of 1,173 rural married women.

Although father's occupation is perhaps one of the most important variables indicating socioeconomic status, it is also possible that father's occupation has other types of effects on child mortality. For example, an occupation that requires long hours or long physical separation may impair the quality of care available for the child. Rural location of certain occupations may interfere with the availability of health services. Occupations that require location in areas of high toxicity may affect child health. It

appears likely, however, that in the vast majority of circumstances the socioeconomic status effects will outweigh those arising from these sources.

The relation between the employment of a mother and the health and well being of her children is not straightforward. In perhaps the most common conceptualization, a mother's occupational status has been regarded as a proxy for maternal time allocated to child rearing (Da Vanzo and Lee 1978). Maternal activity outside of the home is believed to reduce time devoted to child rearing as well as the deterioration in maternal health. An early study of infant mortality in eight cities in the US shows infant mortality rates among offspring of mothers who worked away from home during pregnancy to be about twice the rate for those who were not employed, yet only a sixth higher among offspring of mothers who worked within the home (Woodbury 1975). Employment away from home during the first year of life also appeared to place an infant at greater risk. Woodbury suggests that the limited amount of time that could be devoted to breast feeding, in addition to the more general lack of care that working mothers could give their children, may have been a factor in the higher infant mortality of children of those mothers. Similarly, in a study done in Germany, Knodel and Kintner (1993) find the possible negative effect of female labor participation on breast feeding habits, especially in urban areas, where children are less likely to accompany mothers to work. Similar results were also found in a study done in Great Britain and Northern Ireland based on early 20th century census data (Preston et al. 1981). Chowdhury et al. (1982) found that in Bangladesh, the time spent by the mother on child care had a positive and significant effect on calorie and protein intake and on the dietary adequacy status of pre-school children. Hinderbrand et al. (1985) has documented the significantly higher risks of

death faced by children among the Tamasheq (or nobles) in rural Mali compared to the children of the Bella (or slaves). The latter can hardly claim to have greater economic resources; the main difference between the groups seem to be that Bella children are rarely physically separated from their mothers, whereas the Tamasheq children are cared for by Bella nursemaids, being taken to the mothers only for breast feeding. However, in case of the US, the inclusion of race reduces the mortality differential considerably, leading to the conclusion that labor force participation among married women is primarily a function of economic circumstances which, in turn, is highly associated with race. In Sudan, Farah and Preston (1981) found that children of working mothers had higher mortality rates than those of housewives. They are of the opinion that in cultures that emphasize the importance of the mother's role as full time caregiver, labor force participation may be symptomatic of economic stress in the household.

The nature of a woman's job is also thought to be crucial in children's survival status. This is mainly due to the different time schedule of different activities. In their study based on a Malaysian time budget survey, Da Vanzo and Lee (1978) found that contrary to expectation, agricultural activities appeared less compatible with child care than were sales or productive occupations. Perrenaud (1991) in a study of historical Europe, found that peasants had higher mortality than the landless, possibly because ownership of land entailed more work for the wife.

In summary, the mother's activity status is believed to be indicative of time spent in child rearing and domestic activities. Thus, maternal participation in the labor market is expected to raise child mortality. However, certain conditions may prevent this result: (a) women may be engaged in highly paid jobs that permit them to pay to replace

themselves in child care activities; (b) participation in the labor market is done in a context of flexibility that permits the mother herself to take care of the child (for example when the market activities are performed at home); (c) the mother shares the responsibility of child care activities with other adult members of the extended family; (d) institutionalized child care services of high quality are available.

The degree to which child mortality differentials are explained by activity and employment status, especially of that of the mother is an issue only recently addressed in the literature. The one cross-cultural study that analyzed the effects of mother's work status found that it was rarely significant in multivariate models (Hobcraft et al. 1982)

The Role of Cultural Factors

Religion and Caste

In most societies, marital status and household structure are a reflection of culture. The ethnicity and religion of the family have rarely been included as explanatory factors in the analyses of determinants of infant and child mortality. Several community level studies of mortality in Asian societies include information on ethnic and religious origin. Ruzicka and Kanitkar (1973) and Gupta and Rao (1976) have explored variations in child loss, across religious and cultural communities in India. The former found that in Greater Bombay, Christian women had the lowest and Muslim women had the highest infant mortality and that these differentials were greater during the postneonatal than the neonatal period. Differences in education are suggested as possible explanatory factors. Gupta and Rao note sizable differences in the child mortality ratio by religion and caste for a rural area in southern Uttar Pradesh.

Although only a few efforts have been made to examine the relationship between ethnicity and religion on the one hand and child mortality experience on the other, all studies point toward the existence of such a relationship.

Marital Status and Household Structure

Although very few studies have investigated the relation between marital status, household structure and infant and child mortality, there is evidence that the different patterns of family structure do influence the level of infant and child mortality. In its comparative study of social and biological effects on perinatal mortality, which focuses mainly on developing countries, The World Health Organization (WHO) found that, in all societies studied, illegitimate births had higher rates of perinatal mortality. Much of this higher mortality was attributed to the fact that the birth weight distribution for illegitimate births was lower. Another disadvantage of illegitimate births resulted from being born disproportionately to teen-aged mothers and to women without previous children. A review of Caribbean populations by Roberts (1975) disclosed an infant mortality rate inconsistently higher for illegitimate births. The differential was much larger in the postneonatal than in the neonatal period, which suggests that it may be produced principally by socioeconomic factors, including childcare factors, rather than by endogenous factors present at the child's birth.

Behm (1983) reported in a study on Bangladesh that the mortality rate of children of widowed or divorced mothers was higher than that of the currently married. This conclusion is consistent with the finding of the UN (1973) that children of currently married women very commonly had lower mortality than children of women in any other marital status category. A major explanation of this difference has been the better

socioeconomic condition of the currently married women. However, it is also possible that widowhood and divorce are associated with increased stress, which can in turn compromise child health and child care.

There are several reasons to expect that polygamous marriages in some societies might have lower child mortality. Men who engage in polygamous unions are usually wealthier, so that polygamy can be associated with increased resources for child rearing. On the other hand, these resources have to be shared by more wives and their children, so that the predicted net effect is somewhat ambiguous. Polygamy is mostly associated with a traditional society, which is expected to be associated with traditional health practices. Most studies that have examined differences in childcare between polygamous and monogamous marriages have found that the detrimental effects of polygamy dominate. In Nigeria, the death rate for polygamous unions was a third higher than that of children in monogamous unions (Caldwell 1979). Harington (1971) has revealed that in Burkino Faso, Nigeria and Ghana, infant mortality in rural areas was higher among polygamous unions.

Discontinuities in marriage are expected to reduce the resources available for raising children, particularly children from earlier marriages. Separation of the original spouses means that at least one of them is not physically living with the child and is unable to provide the resources normally expected from them. However, very little empirical work has been done to verify this hypothesis. Ebanks (1983) used World Fertility Survey (WFS) data for Trinidad and Tobago to show that child mortality is higher for mothers who have been in more than one marital union.

Lastly, the presence of other adults and children, including both relatives and non-relatives can also have an impact on infant survival. The availability of other adults in the household, in addition to the parents, is expected to reduce mortality, because these added adults are able to participate in childcare when the parents are absent or indisposed.

Need for Present Study

Several researchers from various disciplines and institutions have studied infant mortality in India. In doing this study, it is my aim to strengthen the results from previous studies and also fill some of the gaps left by previous research. Previous attempts at exploring the determinants of infant/child mortality in India and its regional pattern have been limited to studies done in single regions. Owing to the singular nature of these studies, it is difficult to get an overall picture at either the state or national level. This study will be an attempt at looking at variations in infant mortality at different scales of analysis – national, state, district and individual.

The present study will also add to the literature on spatial patterns created by development in an LDC by shedding light on one of the most important aspects of development. Most previous studies are based on economic variables of income and labor force participation. By using infant mortality as an indicator of development, this study will add a human element to the analysis of spatial disparities in development. In a country like India, where data on per capita income is very sketchy, and the existence of the informal sector makes it difficult to measure labor force participation, the availability of reliable data on infant mortality from the NFHS will enhance an understanding of the spatial disparities in development. Furthermore, in a developing country like India, income is not always an index of development. For instance, the state of Kerala, has one

of the lowest per capita incomes in the country, but ranks first in all aspects of development. Punjab, on the other hand, is one of the richest states but exhibits high infant mortality and a large gender disparity in infant mortality. Under such conditions, infant mortality can serve as a more efficient index of development.

Finally, most previous research (as examined in the literature review) explains infant and child mortality on the basis of a few selected factors like parental education, occupational status, roofing material used in the house, availability of drinking water, land holding, etc. There are several factors that are logically thought to affect infant mortality but have not been considered in previous research, for example flooring material in the house or animal ownership. Diarrheal deaths are some of the major causes of infant and child death in developing countries like India. These diseases are more easily transmitted when children walk barefoot on mud floors especially in the rainy season. Hence, the importance of flooring material cannot be neglected and the present study will include these factors as independent variables. Similarly, health care has long been recognized as an important factor in determining the survival chances of an infant/child, but few attempts have been made to study the empirical relation between these factors. Most studies have made use of number of visits to health care centers as proxy for availability. However, previous research on health care utilization do not clearly indicate the negative impact of distance and whether proximity to a health center improves the survival chances of both male and female infants. The existence of animals within the household compound may enhance the chances of tetanus and thereby reduce survival. The use of medical care at birth and throughout pregnancy and breast-feeding are generally acclaimed as having a positive impact on infant survival. But none of the

previous research has used these variables elaborately, for instance, the number of tetanus toxoid vaccine or the number of prenatal visit, the administration of folic acid tablets, the time at which breast feeding was initiated, etc. These new factors have been included in the present study.

Hypotheses

There is considerable documentation that infant and child mortality in India exhibits great diversity and distinct regional patterns. Most previous research has found a north-south divide demarcating a high mortality region in the north and a lower mortality region in the south. However few rigorous empirical tests of the argument have emerged to date, since most of the studies are either at the individual level or at a very high level of aggregation across states. In this research, I address the issue of a north/south dichotomy at the district level, which allows for a better understanding of the distribution of infant mortality in the country with special reference to the north/south divide. Thus I hypothesize (H_1) that there are significant regional variations in infant mortality in India.

Within the neoclassical framework of development economics, the distribution of a variable measuring development, such as income or infant mortality is characterized by macro regions indicating high or low components of the variable creating the core and periphery of development, respectively. Within these macro regions, there might be internal variations at the micro-spatial level. With time the distributional pattern changes toward divergence or convergence until spread effects of development bring about a convergence of development in the macro region. However, in some cases, increasing internal variation in the distribution of the variable in the sub regions can create micro margins or small areas of poverty within highly developed regions. For instance, while

studying macro and micro spatial disparities in income in Michigan, Sommers, Mehretu, and Pigozzi (1996) have found that the highest internal variation in income is observed in the richest counties while the lowest variation is observed in the poorer counties. In this study the states are considered as macro regions and the districts within are considered as micro regions in order to examine whether similar internal variation in infant mortality can be observed in case of India. Based on this theoretical framework, I hypothesize (H_2) that states with low levels of infant mortality are associated with low internal variation in infant mortality between its sub regions.

Most previous research on infant mortality has found a regional dichotomy in the spatial pattern of female disadvantage in child mortality in India. South Indian society is characterized by higher female autonomy, a higher status for women and better female survival. However, most studies have looked into gender differentials in survival from a macro level. In this study, I analyze the gender differentials in infant mortality at the district level and with respect to the regional divide between the north and south. In order to study gender differentials at the district level, I hypothesize (H_3) that there is significant regional variation in the gender differential in mortality characterized by a north/south dichotomy where the northern part of the country is associated with greater female disadvantage.

Gender has been found to be a significant determinant of survival during infancy and childhood and this gender differential in survival reflects the differences in their biological make up. Thus, higher male mortality as compared to female mortality is a biological axiom. Any deviation from this norm is indicative of an undervaluation of females relative to males and suggests gender discrimination "in access to the right to

live". Previous studies have shown that gender is a significant factor in child survival in India. However, contrary to the biological norm of higher female survival, females have suffered higher mortality in the north. Based on these previous studies, I attempt to extend this finding to the first year of life, in order to test whether these gender disparities in mortality are evident during infancy and whether the north south divide can still be applicable. Thus I hypothesize (H_4) that the gender of an infant is significantly related to its chances of survival with higher female than male mortality in the north and lower female than male mortality in the south.

In addition to the gender of the index child, the gender of the previous child can also affect the survival status of the index child. To examine the impact of the gender of the previous birth on the survival status of the index child, I hypothesize (H_5) that the gender of the previous birth is significantly related to the chances of survival of an infant, both in the north and the south.

In a society where son preference is culturally embedded in the family building process, it can be expected that not only the gender of the index child (the infant in question) and the gender of the previous child, but the gender composition of other surviving children will have an impact on the survival status of the present child. Having a greater number of surviving older male siblings can improve the survival chances of infants both male and female. The birth of a son in a family, which already has some older male children, is considered as an insurance against any possible future mortality risks. Also, after having the desired number of sons in the family, the arrival of a daughter can be welcome and her survival status improved. But it is also true that the birth of a daughter following several sons reduces her chances of survival since she can

be expected to be at a disadvantage with respect to the limited resources in the household, especially food. To study the impact of the gender composition of the household on infant survival, I hypothesize (H_6) that the gender composition of the family significantly affects infant survival in the northern and southern parts of the country.

Although breast feeding and medical care at birth are widely recognized as positive steps in improving infant and child survival in medical literature, few attempts have been made to evaluate the simultaneous contribution of these factors along with other socioeconomic factors in improving infant survival chances. Furthermore, since medical care during pregnancy and at the time of birth are usually provided without the prior knowledge of the gender of the infant, it can be expected that these factors could improve male as well as female infant survival. In this research, I try to ascertain empirically whether breast feeding and medical care throughout pregnancy and at the time of birth improve the chances of survival of both male and female infants and whether this is true for the infants in the north as well as the south. I hypothesize (H_7) that breast feeding significantly improves male and female infant survival in the northern as well as southern states of India, and (H_8) that medical care significantly improves male and female infant survival both in the north and south.

Among the factors that have a strong influence on infant/child mortality, education especially female education is now widely considered one of the most powerful. At the most obvious level, educated women are likely to be more knowledgeable about nutrition, hygiene and health care. Education can also be important in helping mothers to demand adequate attention to children's needs by other members of the household, to take advantage of public health services, and generally to pursue the

well-being of her children in a more informed and effective way. However, it is still unclear how the employment of women, which is often a result of education, affects infant survival. Furthermore, the link between female education and the gender differential in survival is also far from clear. Previous empirical studies have suggested that female education could (1) improve the survival chance of sons only since the mothers would be in a better position to "keep the mortality of undesired children high by withholding the requisite care" (Dasgupta 1987) or perhaps because educated mothers have low fertility which might be associated with higher gender bias (Dasgupta and Mari Bhat 1995). (2) improve the survival chances of female infants more than male infants (Simmons et al. 1982; Murthi et al. 1995) since mothers would realize the worth of their female daughters and strive to improve their economic significance in society. (3) a combination of improving male or female survival, depending on the region of residence and birth order (Basu 1992; Bourne and Walker 1991; Amin 1990). Several other studies suggest that no simple relationship between female literacy and gender bias can be established (Chen et al. 1981; Sen and Sengupta 1983; Caldwell, Reddy, and Caldwell 1989). In this study I try to fill this gap in previous research by examining how maternal education affects male and female infant survival and create regional variations in the gender differential in infant mortality. I hypothesize (H_9) that maternal education significantly improves the survival of infants, especially female infants, both in the north as well as the south.

Availability of health care services and physical proximity to these services can reasonably be expected to improve infant survival. However, the functioning of these health services can also be of equal importance. For instance, in some rural areas

especially in northern India, some facilities especially those at the lowest level of the hierarchy are often used only as family planning clinics and there are no resources or personnel to treat sick infants. The utilization of health care services involves a cost, often an opportunity cost especially if the center is at a distance from the village. Under such circumstances, and in a cultural milieu where male infants are preferred, physical proximity to health care can be expected to improve only male survival since parents would be interested in the health status of the male infants and proximity to the center would trigger the utilization of the service. On the other hand it could also be true that physical proximity to a health center could increase the possibility of bringing in a sick female infant since very little would be "wasted" as opportunity cost. In this study, I try to examine the relation between physical proximity to a health center and infant survival and how distance affects male and female survival differentially in the northern and southern states. To understand the relation between proximity to health care and survival of infants, I hypothesize (H_{10}) that proximity to a health center improves infant survival, especially female survival both in the northern as well as southern states in India.

For both social and biological reasons, a marriage between relatives has implications on infant mortality. Due to biological reasons, infant mortality is significantly higher in consanguineous marriages. However, it is true that consanguineous marriages ease out the strains and stresses that are experienced by young women in an arranged marriage, who are in an unknown household and away from their natal home. Often times this improves the status of the newly wed within the family. This could be expected to improve the survival of her children since the mother would be in a position to demand adequate attention to the needs of her infant. The prevalence of

consanguineous marriages varies between different parts of the country, most of the southern states having a higher percentage of couples in such marriages. In order to determine how consanguineous marriages affect the chances of infant survival in the northern and the southern states, I hypothesize (H_{11}) that mortality of male as well as female infants is significantly higher in households with consanguineous marriages, both in the northern and southern parts of the country.

The relationship between poverty and infant survival deserves careful examination. There is general evidence in the literature to show that rising incomes typically lead to lower infant mortality. However, there are no simple associations in the relation between poverty and gender differentials in survival. On the one hand, the survival of male and female infants are both improved with increasing incomes, since the strain on the limited resources is reduced and the female infant is provided an equal share of the resources necessary for growth and survival. On the other hand, some studies have found that discrimination against female children is less intense among poorer households leading to an improvement in survival only of the female infants. For a better understanding of this relationship, I use land ownership as a proxy for wealth in order to examine whether it improves infant survival and also whether these improvements are comparable between the north and the south. For a better understanding of this relationship, I hypothesize (H_{12}) that in both the northern and southern regions of the country, infant survival especially female survival is significantly higher in households with a higher level of land ownership.

III. DATA AND RESEARCH METHOD

This chapter sheds light on the data and methodology used in this analysis of infant mortality and its spatial and gender disparities. It provides an introduction and explanation of the statistical methods that are used in this research.

Data

The data used for the present study were derived from two secondary sources. The first data set represents census data from the year 1991. The census data were acquired from the provisional reports published by the Office of the Registrar General and Census Commissioner, India. It covers 31 states and Union Territories and 452 districts. The 1991 Census was not held in the northern state of Jammu and Kashmir due to political unrest and unlawful terrorist occupation propagated by Pakistan and China (Census of India 1991). The use of census information is limited to district level information on scheduled castes, scheduled tribes, literacy, and percentage of population in the work force. Census information on infant births and deaths is not used in this study due to the incomplete coverage in some of the border and inaccessible districts. Also birth and death information from the census is often inconsistent due to a general lack of knowledge about dates among the rural people. The 1991 census count was conducted in India during the month of February and a revisional round conducted during March 1-5, 1991. In certain inaccessible areas, however, the enumeration was carried out non-synchronously.

The second and more important data set was obtained from the National Family Health Survey (NFHS) conducted in India in 1992-93. Funded by the USAID, initiated by the Ministry of Health and Family Welfare (MOHFW) and coordinated by the

International Institute of Population Sciences, the NFHS was carried out as the principal activity of a collaborative project to strengthen the research capabilities of the Population Research Centers (PRC) in India. Technical assistance was provided by the East-West Center in Hawaii and a US based private corporation named Macro International, located in Maryland. The NFHS provides information on infant births and deaths, as well as some socioeconomic, cultural, demographic, geographic and medical variables. In the absence of a complete births and deaths registration system, and with a census, which usually suffers from imperfect coverage, this is the most complete survey of its kind that has ever been conducted in India.

The NFHS covers 24 states and the National Capital Territory of Delhi (the erstwhile Union Territory of Delhi, which recently attained statehood), which comprise 99 percent of the total population of India (excludes the Himalayan state of Sikkim and some highly sensitive border areas). In all, 89,777 ever-married women age 13-49 and 855,562 households are covered, using uniform questionnaires, sample designs and field procedures. Out of the 855,562 households that were interviewed, 2/3rds were rural. The data collection was carried out on a state-by –state basis from April 1992 to Sept 1993.

Sample Design, Size and Allocation

The sample design adopted in each state is a systematic, stratified sample of households, with two stages in rural areas and three stages in urban areas. The sample size for each state was specified in terms of a target number of completed interviews with eligible women. The target sample size was set considering the size of the state, the time and resources available for the survey and the need for separate estimates for urban and rural areas of the state.

The Rural Sample

A two-stage stratified sampling design was adopted for the rural areas: selection of villages followed by selection of households. Villages were stratified prior to selection on the basis of a number of variables. The first level of stratification in all the states was geographic, with districts subdivided into regions according to their geophysical characteristics. Within each of these regions, villages were stratified using some of the following variables: village size, distance from the nearest town, proportion of non-agricultural workers, proportion of the population belonging to scheduled castes/ scheduled tribes, and female literacy. However, not all variables were used in every state. Each state was examined individually and two or three variables were selected for stratification, with the aim of creating not more than 12 strata for small states and not more than 15 strata for large states. Primary Sampling Units (PSU) were selected systematically, with probability proportional to size (PPS). In some cases adjacent villages with small population sizes were combined into a single PSU for the purpose of sample selection. On an average, 30 households were selected for interviewing in each selected PSU.

The Urban Sample

A three-stage sample design was adopted for the urban areas in each state: selection of cities/towns, followed by urban blocks, and finally households. All cities and towns were subdivided into 3 strata: (1) self- selecting cities (i.e., cities with a population large enough to be selected with certainty), (2) towns that are district headquarters, and (3) other towns. Within each stratum, the cities/towns were arranged according to the same kind of geographic stratification used in the rural areas. In self-selecting cities, the

sample was selected according to a two-stage sample design: selection of the required number of urban blocks, followed by selection of households in each of the selected blocks. For district headquarters and other towns, a three-stage sample design was used: selection of towns with PPS, followed by selection of two census blocks per selected town followed by selection of households from each selected block. As in rural areas, a household listing was carried out in the selected blocks, and an average of 20 households per block was selected systematically.

Three types of questionnaires were used in the NFHS: the Household Questionnaire, the Woman's Questionnaire and the Village Questionnaire. The Household Questionnaire was used to list all usual residents of each sample household, plus all visitors who slept in the household the night before the interview. Some basic information was collected on the characteristics of each person listed, including age, gender, marital status, education, occupation and relationship to the head of the household, as well as health status. In addition, this questionnaire also collected information on household conditions, such as source of water, type of toilet facilities, materials used in the construction of the house, source of lighting, cooking fuel, ownership of agricultural land and livestock, ownership of various consumer goods, and characteristics of the head of the household, such as religion, caste or tribe. The Household Questionnaire also included household birth and death records wherein all the live births and deaths that took place within the last 2 years in the household were recorded.

The Woman's Questionnaire was used to collect information from eligible women, i.e., all ever-married women, usual residents as well as visitors, age 13-49 years.

This questionnaire consisted of 7 sections – namely, respondents' background information (age, marital status, etc.), reproduction (total number of sons and daughters, complete birth history of each of the live births), contraception (knowledge and use of family planning methods), health of children (antenatal care, breast feeding, immunizations and illness episodes), fertility preferences (demand for additional children, ideal family size, etc.), husband's background and woman's work (age, education and work status of husband and wife), and the nutritional status of children (height and weight).

The Village Questionnaire was used to collect information on all villages covered in the NFHS. The Village Questionnaire included information on various amenities available in the village, such as electricity, water transportation and educational and health facilities.

Compilation and Organization of Data

The census data for 1991 was available in published tabular format for each district and state in India in 3 separate volumes of census abstracts. The data from the NFHS was available in SPSS format in diskettes that contained zipped files for each state, along with a detailed codebook. In addition, published summary reports were available for all the states. The data files were available in three different structures and any one of the structures could be used depending on platform requirements. The three structures were – flat, hierarchical and rectangular files. Since the flat file is better suited for mainframe users, and the hierarchical file for particular systems of the NFHS, I used the rectangular file, which is best suited for use on microcomputers. The 3 files- Household, Individual and Village were in three different units of analysis – the

Household file had information on each household, the Individual file on eligible women in a household and the Village file had information on villages in which the households were located. The original data from the 3 files was combined using the 11 digit case identification so that a woman became the smallest unit with information on her household as well as the village in which she lived. This case identification number consists of 9 characters from the household file and 2 from the individual file. This ID is constructed from the 2 digit state code, followed by the 3 digit Primary Sampling Unit (PSU) code and the 4 digit household number and the 2 digit woman's line number code.

One of the challenges faced in compiling the data was the identification of eligible cases for the analysis. Important dates in the original data file were expressed as Century Month Codes. A century month code (CMC) is the number of months since the start of the century. For example, January 1900 is CMC 1, January 1901 is CMC 13, January 1980 is CMC 961, and August 1990 is CMC 1088. The CMC for a date is calculated from the month and year as follows:

$$CMC = (YY * 12) + MM$$

In order to extract children born up to 5 years prior to the survey or within a specific time period prior to the survey, the actual dates that were needed for children to be eligible had to be converted to the CMC dates. If the child's birth date in CMC was subtracted from the mother's interview date in CMC and yielded a remainder less than 60, the child was identified as having been born within five years of the NFHS.

Compilation and selection of data was done in two stages –

(1) This study has been organized in two parts. The first part deals with the spatial disparities in infant mortality. In this section, the study area is divided into two

spatial units of analysis – namely districts and states. In order to analyze the infant mortality situation in the country, the number of births in each district during the 5 years prior to the survey are extracted. These births in each district are grouped into three categories namely neonatal deaths (those infants who died during the first month of birth), postneonatal deaths (those infants who died between 1 – 11 months of birth) and those who are living beyond the 11^{th} month of life. These groups are estimated separately for males and for females. They are then used to determine the neonatal, postneonatal and infant mortality rates for individual districts. Once these figures are calculated, they can be aggregated to derive the state rates. Once the infant mortality rates for each district is calculated, they are used to determine the male female disparity in infant mortality in each district as well as in the states. The mortality rates in each district are then used to determine the disparity between districts within a state by using the Coefficient of variation (CV) and location Quotient (LQ) methods.

Thus districts instead of women (as in the original data file) became the smallest unit of analysis.

(2) The second stage of the analysis focuses more on an in depth analysis of the relation between various independent variables and infant mortality, in the northern and southern regions of India. While the first part of the analysis gives an overall view of the infant mortality situation in the country with its gender and spatial disparities, this section goes further in looking for causal connections. In this section, I try to focus on the factors that determine variations in infant mortality between the two major spatial units represented by the northern and the southern states. For this analysis, individual level data, i.e., an individual infant forms the unit of analysis. Multinomial Logit models

are used to study the factors that affect infant mortality in the rural areas of the four selected states of Uttar Pradesh, Haryana, Kerala, and Tamil Nadu and how these factors differentially affect male and female survival in the north and the south. Initially, I started with a comparison between two states, namely, Uttar Pradesh (UP) in the north and Kerala in the south. Uttar Pradesh seemed to be a right choice from the north because it is the most populous state in the country and has one of the highest infant mortality rates. It also depicts a situation of female disadvantage in infant and childhood mortality. Kerala on the other hand has some of the best social indicators in the country and it seemed appropriate to study how the same variables affect infant mortality in these two diverse settings. Although data from UP could be used in my mathematical models, I found that there were too few cases of infant deaths in Kerala to the extent that no results could be obtained from the model. In order to increase the number of cases from the south, I added the adjacent state of Tamil Nadu (TN) as a second state from the south. I also added the state of Haryana as a second state from the north because Haryana has the highest male female differential in infant mortality (the ratio of male to female infant mortality is .63, which is the lowest in the country). The study had to be restricted to rural areas only because information on the distance variables, for example, distance to a Primary Health Center (PHC) or a Hospital (H) was available only for the rural areas.

Once the states were selected, I proceeded to extract data from these states. Initially I started with children born between 13-24 months prior to the survey. I used 13 months as the lower cut-off to avoid selectivity bias, i.e., to provide every infant the opportunity to survive up to 12 months from birth or through infancy. Infants born between 13-36 months prior to the survey were selected. This increased the size of my

sample to include children born in 2 consecutive years. For children born between 13 to 36 months prior to the survey, the dependent variable was coded as 1 for neonatal deaths, 2 for postneonatal deaths and 3 for children surviving beyond infancy.

To examine the effect of gender on infant mortality, gender is entered into the regression equation as a dummy variable, which takes the value of 0 if the child is male and 1 if the child is female. Gender of previous birth is entered as 1 if male, 2 if female and 0 if first birth. In order to assess the relation between gender composition of the family and infant mortality, two sibling gender variables were added to the analysis. Several of the independent variables considered are categorical but ordered including educational attainment. One possibility is to code them as sets of dummy variables but this method is often unparsimonious and computationally expensive (Raftery, Lewis, and Aghajanian 1995). The number of living older male siblings and the number of living older female siblings which were two separate variables similarly coded as 1 if the infant has no living older male/female sibling, 2 if the infant has 1 living older male/female sibling, 3 if the infant has 2 to 3 living older male/female siblings and 4 if the infant has 4 or more living older male/female siblings. Distance from a health center (Hospital, Primary Health Center, Subsidiary Health Center, or the nearest health center whichever it might be) is entered into the equation in the form of distance in kilometers. In addition to actual distance, the level of the nearest health center is also entered into the equation in the form of a variable which takes on the value of 1 if a Primary Health Center (PHC) is nearest, 2 if a Sub Center (SC) is nearest, 3 if a Hospital (H) is nearest, 4 if a PHC and SHC are at an equally close distance, 5 if a SHC and H are at an equally close distance, 6

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if a PHC and H are at an equally close distance and 7 if all three facilities are at an equal distance.

Besides these major independent variables, the regression equations control for a set of explanatory variables given in Table 1. Socioeconomic status of the household is measured by 3 different variables: an asset ownership index or ownership of household commodities, which varies between 0 and 16, based on how many of the 16 assets the household owns. All assets are weighed equally. The number of assets held by the household are summed and divided by the maximum of assets that can be possibly owned which is 15 in this case. These assets include sewing machine, clock/watch, sofa set, fans, radio/transistor, refrigerator, television, VCR/VCP, bicycle, motorcycle/scooter, car, tractor, thrasher, bullock cart, water pump, and animals. Similar indices have been used in other studies (Kishor 1997). The Housing facility Index varies from 3 to 14. This index is a combination of several characteristic constituents of the house in which the child or infant resides. In this case some characteristics of the house are weighted more than the others based on some previous research (Patel 1981; Sloan 1971; Kishor 1997). Most of these indices are modifications of the scale developed by Pareek and Trivedi (1964) and later used by several researchers (Gandotra and Das 1988; Kanitkar and Murthy1988; Gunasekharan 1988). In all these studies, each household to which an infant belongs, is assigned a prescribed score on each item or characteristic. The sum of these scores indicates the overall value of the index for that particular household.

These characteristics include:

(a) Number of rooms in the house

1 – 2 (1), 3-4 (2), 5-9 (3), more than 10 (4)

(b) Type/Structure of house

Kachha/temporary (1)

Semi Pucca/Partially permanent (2)

Pucca/Permanent (3)

(c) Separate cattle/animal space outside the house (1)

(d) Type of fuel used

Electric/gas/biogas (3)

Charcoal/kerosene (2)

All others (1)

(e) Separate room as kitchen (1)

(f) Type of toilet

Own flush or pit toilet (1)

(g) Main source of lighting

Electricity (1)

The number in parentheses is the weight given to the particular characteristic of the house in calculating the index. The total land owned by the family of the infant is measured separately for irrigated land and non-irrigated land in acres and forms the third variable indicating socioeconomic standard of the household.

The impact of cultural factors on infant mortality is measured by the two variables of religion and caste. The religion variable is coded as 0 for Hindus, 1 for Muslims and 2 for people belonging to a third religion. The third religion category is state specific, for instance in case of the southern states of Tamil Nadu and Kerala the third religion is Christianity, while for the northern state of Haryana, it is Sikhism. In some states as in

the case of the northern state of Uttar Pradesh, the predominance of the first two religions eliminates the existence of any major third religious category. The scheduled caste variable has a value of 0 if the infant belongs to a scheduled caste, 1 if it belongs to a scheduled tribe and 2 if it does not belong to either. The scheduled castes correspond in general to the castes that were the former 'Untouchables'. They are now known as scheduled castes because they are listed in a separate schedule of the Constitution of independent India as requiring special consideration. Similarly, people belonging to the schedule tribes are generally tribal communities from hilly areas or aboriginal minority population who have been listed in the constitution for special consideration. Unlike the scheduled tribes, people belonging to the scheduled castes originate only from the Hindu religion. Type of marriage is entered into the regression as a dummy variable, which is coded as 0 in case of consanguineous marriage and 1 in case of a non-consanguineous marriage. For the purpose of this study, this variable not only serves as a cultural delimiter, but, also acts as a proxy for the relative status of women in different parts of the country, since prior family ties tends to minimize the initial fears that a young bride has in acquiring a prominent place in the husband's household (Dyson and Moore 1983; Malhotra, Vanneman and Kishor 1995; Kishor 1996).

To examine the effect of mother's education on infant mortality, education is entered into the regression in 2 different ways: first as a variable that has 4 categories and takes the value of 0 when the mother is illiterate, 1 when the mother is primary school literate, 2 if she had been to middle school and 3 if she had been to high school; and then as a 6 category variable where 0 indicates illiterate, 1 literate but primary school incomplete, 2 primary school complete, 3 middle school complete, 4 high school

complete and 5 University. Similarly, to study the effect of mother's employment on infant mortality, employment is entered into the regression equation in two different ways: as a variable which takes the value of 1 if the mother works for a family member, 2 if she works for someone else, 3 if she is self employed and 0 if she is not employed, and then as a 3 category variable capturing the type of employment: 1 if employed for cash, 2 if employed without earning cash and 3 if not working at all. Child care is included in the regressions by a 2 category dummy variable which takes the value of 0 if the child is cared for by the mother only, and 1 if the child has another care giver in addition to the mother. In addition to gender of present infant and gender of previous birth, age of mother, birth interval and birth order are included in the regression as demographic variables. Age is included in the regressions in the form of a variable that takes the value of 0 if the age of the mother is between 13 and 19 yr., 1 if she is 20 or 34 years and 2 if she is above 35 years of age. Length of previous birth interval is a dummy variable that has two values: less than 24 months (1) and a first birth or interval more than 24 months (0). The child's birth order varies from 1 to 10 since up to 10 births for each mother was extracted from the data. The birth order of each infant was coded as 1 for first births or eldest child in the family, 2 for parity 2 and 3 or second or third births and 3 for parity 4 and above or fourth birth or beyond.

In addition to distance from various levels of health centers, distance from source of drinking water is also entered into the regressions as time taken to travel to source of drinking water. The regions of the states are also included into the regressions as categorical variables to differentiate between the regions in the two study states in the north and the south.

A set of variables is included into the regression equations to capture the impact of medical factors both prior to and at the time of birth. The pre birth medical index combines the effect of time of first medical check up, use of folic acid tablets and administration of tetanus shots during pregnancy. The timing of antenatal checkup at home as well as in a health center is coded as 1 if started during the third trimester of pregnancy, 2 if during the second trimester of pregnancy, 3 if started during the first trimester of pregnancy and 0 if there was no checkup. The use of folic acid tablets during pregnancy was coded as 1 and the administration of antitetanus venom was coded as 1 for 1- 2 shots, 2 for 3 or more shots and 0 for none. It has been proved by several studies in developing nations that the best protection against tetanus is to have more than two shots during a certain period of time. These variables were summed together to form the prebirth medical index. The birth medical index takes into account the place of delivery (coded 1 if born at home, 2 if born in a Government/Municipal hospital, PHC or SHC and 3 if born in a Private hospital), time of delivery coded 1 for on time deliveries, complications during delivery (coded as 1 in the absence of such complications), and the size of the infant at birth (coded as 3 for large, 2 for average and 1 for small). Breast feeding was entered into the equations in two different ways: first as a dummy variable which takes the value of 1 if the infant is breast fed and 0 otherwise, and then in the second equation as a two factor variable capturing the time at which breast feeding was initiated (coded 1 when breast feeding was started days after the birth of the infant, 2 if hours after the birth and 3 if started immediately after birth) as well as the administration of antigens through the first milk flow (1 if first milk was fed to the baby and 0 if first milk was squeezed out). The two factor form of the breast feeding index could be used

only in case of the last born children extracted for a particular time period since detailed information about breast feeding were asked only for the last births in the birth history of children born to eligible women.

Region of residence is entered into the equations to indicate the regions within the component states.

Data Analysis

Determination of Infant Mortality Rates

In order to examine the infant mortality scenario in the country and study the gender and spatial disparities therein, the infant mortality rates are calculated at the district level for all the states in India. To extract relevant data all children born within the 5 years prior to the survey were selected. Out of this set, three different categories of infant deaths were analyzed namely neonatal deaths, postneonatal deaths and infant deaths (definitions in the introductory chapter).

These mortality rates were calculated as follows:

(1) Infant Mortality Rate(IMR)

$$IMR = \left[deathsbetweentheagesof\,0daysand11months \Big/ livebirths \right] * 1000$$

(2) Neonatal Mortality Rate (NMR)

$$NMR = \left[deathsbetween0daysand1month \Big/ livebirths \right] * 1000$$

(3) Postneonatal Mortality Rate (PNMR)

$$PNMR = \left[deathsbetween1and11months \Big/ livebirths \right] * 1000$$

This method of calculating the infant mortality rate is comparable to the conventional method and is the simplest approach to estimate the rate of infant deaths in

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a particular year. However, estimates of infant mortality from this study may vary from the state level published reports of the NFHS. In the NFHS, the mortality estimates are not rates, but are probabilities, calculated according to the conventional life table approach. A life table describes the experience of a hypothetical cohort based on age- or duration specific rates observed in a single year or a short period of time. The current age or duration-specific rates are converted into the probability of surviving or dying (in case of mortality) and are then applied to a hypothetical cohort to study a particular experience (Rutstein 1984).

Determination of Gender Differences

A difference in the mortality of female children compared to the mortality of male children indicates gender discrimination in access to the right to live. As indicated, excess male mortality is the biological norm (Waldron 1983) and characterizes most developed and underdeveloped countries (Preston & Weed 1976; Hammond 1977; UN 1983). Thus, persistent excess mortality among females would suggest that females are undervalued relative to males. To determine the gender disparities in the mortality rates, the ratio of male to female mortality rates were measured. Thus, D_j, the gender difference in mortality between the age of 0 to 1 year in district $_j$ is measured as:

$$D_j = \left[(IMR_m)_j \Big/ (IMR_f)_j \right]$$

where:

IMR = Infant Mortality Rate

m=male

f=female

j=respective district

Because male mortality as a result of daughter preference is rare, Dj can be unambiguously interpreted: the lower the value of D_j, the higher the discrimination against females, and thus the greater the gender inequality in infant mortality. Gender differentials in mortality are also determined for the neonatal and postneonatal phases.

Determination of Spatial Patterns of Disparity

There is some documentation that infant mortality exhibits not only great diversity but also some distinct regional patterns (Sopher 1980; Miller 1981; Dyson and Moore 1983; Jain 1985; Sen 1986; Basu 1994; Kishor 1996). However, no rigorous empirical tests have emerged to date, largely because most research on mortality is conducted at the micro level, using data from individuals. Adequate data at the appropriate level are generally not available or are compounded by serious limitations. At best, empirical documentation shows only a rough geographic pattern across the north and south or across states which is a relatively high level of aggregation in itself (Jejeebhoy 1986; Srinivas et al. 1984; Kishor et al. 1995). In this study, to examine the spatial patterns of disparity, the infant mortality rate for individuals is aggregated at the district and state levels. The district level data is used to investigate the spatial patterns and to reveal internal variations in infant mortality. The statistical methods used are the Coefficient of Variation (CV) and the Location Quotient (LQ). Additionally, a series of maps have been used to depict the spatial pattern of various measures of mortality and its gender differentials.

(1) Coefficient of Variation (CV)

The coefficient of Variation (CV) provides a relative measure of variability by expressing the standard deviation as a ratio of the mean, or more usually, as a percentage of the mean as in :

$$CV_i = S_i / X_i \quad \ldots(5)$$

where:

S_I = Standard deviation of data of interest for i^{th} place

X_I= Mean of data of interest for the i^{th} place

(2) Location Quotient (LQ)

Location Quotients measure socio-economic conditions based on per capita distribution.

$$LQ_i = \frac{V_i / B_i}{\sum_i V_i / \sum_i B_i} = \frac{V_i / \sum_i V_i}{B_i / \sum_i B_i} \quad \ldots(6)$$

where:

V_I = Variable of interest for place i

B_I = Base variable for place i

An LQ, which exceeds unity, indicates that the region is disadvantaged in the distribution of that attribute. Further insights into the extent of spatial inequality in the distributions were derived graphically and mathematically using the Lorenz Curve (Darden and Tabachneck 1980).

(3) Gini Coefficient (GC)

The Gini coefficient used in analyzing this inequality was derived from the formula:

$$G = \frac{1}{2}\sum_{i=1}^{n}\left|\left(\frac{V_i}{\sum_i V_i}\right)-\left(\frac{B_i}{\sum_i B_i}\right)\right| \quad \ldots(7)$$

where:

V_I = Variable of interest for place i

B_I = Base variable for place i

Perfect equality of the measures of distribution is zero while a score of 1 indicates perfect inequality.

Besides the GC, LQ and COV, there are several alternative methods that can be used to measure dissimilarity such as range, relative mean deviation, variance and standard deviation of the natural log (Cowell 1977). Among the various methods to study spatial disparity, the GC and the CV are the most common methods used to measure dissimilarity (Smith 1982) and has better characteristics compared to the others. The GC is more sensitive to characteristic differentials, independent of proportional changes in characteristics and population, avoids the arbitrary squaring procedure, and is a direct measure of characteristic differences (Cowell 1977). The COV is a more comprehensive measure than the previous measures and is sensitive to differences from the mean like the variance, and independent of the mean characteristic. Therefore, this study uses the Gini coefficient and coefficient of variation to measure disparities in the regional distribution of infant mortality.

Multinomial Logit Regression

After a general examination and description of the spatial and gender differentials in infant mortality, this study focuses on the impact of several independent variables on the survival /death of an infant. This part of the analysis is based on a Multinomial Logit Regression Model. After a preliminary analysis of bivariate associations between infant mortality and a plethora of variables (explained in previous sections) multinomial logit models are used to study the independent as well as interactive effects of all predictors on the probability of infant survival. Table 3.1 gives a list of the independent variables and their categories as used in these models.

The logit model is a reformulation of the general linear model for the specific cases when the dependent variable takes on a binary or categorical form. It specifies a functional relationship between a basically dichotomous/categorical dependent variable and either categorical or metric scaled independent variables. The main advantage of the logit model is that the analysis and interpretation are quite similar to the well-known procedures of multiple regression with some moderate differences. It provides a convenient means to study cases where the dependent variable is a dichotomy or is categorical and the independent variables are both continuous and categorical.

Table 3.1
List of Independent Variables and their Categories as Used in this Research

Independent Variables	Independent Variables
Gender	**Moccu1 (Mother's Occupation)**
Male	Not working
Female	works for family member
Prevbi (gender of previous birth)	works for someone else
First Birth	self=employed
Male	**Moccu2 (Mother's Occupation)**
Female	Not working
Premale (Number of surviving older male siblings)	earns cash for work
None	no cash for work
Only 1	**Chcare (Childcare)**
2 - 3	mother only
4 or more	additional caregiver
Prefem (Number of surviving older female siblings)	**Caste**
None	general
Only 1	scheduled castes
2 - 3	scheduled tribes
4 or more	**Religion**
Birthord (Birthorder)	Hinduism
First Birth	Islam
Parity 2 and3	Christianity
Parity 4 or above	Sikhism
Birthint (Birth Interval)	**Rehw (Blood relation between parents)**
First Births or interval=>24 months	Parents related prior to marriage
<24 months	Parents not related prior to marriage
Agem (Age of mother)	**HFI (Housing Facility Index)**
<20	**Irrigated land**
20 - 34	**Non irrigated land**
>35	**Hcom (Household commodities owned)**
Edum4 (Mother's Education)	**PMI (Prebirth Medical Index)**
illiterate	**BMI (Birth Medical Index)**
literate-primary	**BFI (Breast Feeding Index)**
middle complete	**BFD (Breast feeding)**
High School plus	Breastfed
Edum6 (Mother's Education)	Not Breastfed
illiterate	**Distance**
literate-primary incomplete	Distw (to water time)
primary complete	Distn (to nearest townin Km.)
middle school complete	Distsc (to Subsidiary Health Centerin km.)
High School complete	Distphc (to Primary Health Center in km.)
University	Disthc (to Government Hospital in Km.)
Region (Region of Residence)	D (to any nearest Health Centerin Km.)
Uttar Pradesh	**Lnhc(level of nearest health center)**
Haryana	

In the present case, our dependent variable is trichotomous with categories 1,2, and 3 where 1 indicates neonatal deaths, 2 indicates postneonatal deaths and 3 indicates living children. Let P_1, P_2, and P_3 be the probability that the i^{th} individual in the sample is in categories 1,2,and 3 respectively, on this variable. Also, let $X_1, \ldots\ldots\ldots\ldots\ldots X_k$ be a vector of predictors measured on the i^{th} individual in the sample. Then we model the log odds of being in the category of interest as a linear function of the explanatory variables. Since there are two nonredundant independent contrasts that can be constructed with odds, we have more than 1 equation. For example, we can consider the log odds of being in category 1 versus category 3. Expressed as a function of the predictors, this becomes

$$\ln\frac{P_1}{P_3} = \beta_0^1 + \beta_1^1 X_1 + \beta_2^1 X_2 + \ldots + \beta_K^1 X_K \ldots(8)$$

Whereas the log odds of being in category 2 versus category 3 is modeled as

$$\ln\frac{P_2}{P_3} = \beta_0^2 + \beta_1^2 X_1 + \beta_2^2 X_2 + \ldots + \beta_K^2 X_K \ldots(9)$$

The superscripts on the betas are to indicate that we have 2 different sets of parameters, one for each separate log odds above. One could, of course, also consider the odds of being in category 1 versus category 2, the third contrast among the 3 categories. The equation would be

$$\ln\frac{P_1}{P_2} = \beta_0^3 + \beta_1^3 X_1 + \beta_2^3 X_2 + \ldots + \beta_K^3 X_K \ldots(10)$$

However, the 3rd set of parameters in the equation is just a linear combination of those in (8) and (9), and therefore only the first 2 sets of betas need to be estimated from the data.

This is easy to see, since

$$\ln \frac{P_1}{P_2} = \ln \frac{P_1/P_3}{P_2/P_3} = \ln \frac{P_1}{P_3} - \ln \frac{P_2}{P_3} = \beta_0^1 + \beta_1^1 X_1 + \beta_2^1 X_2 + \ldots + \beta_K^1 X_K$$

$$- \left(\beta_0^2 + \beta_1^2 X_1 + \beta_2^2 X_2 + \ldots + \beta_K^2 X_K\right)$$

$$= \beta_0^1 - \beta_0^2 + \left(\beta_1^1 - \beta_1^2\right) X_1 + \left(\beta_1^1 - \beta_2^2\right) X_2 + \ldots + \left(\beta_K^1 - \beta_K^2\right) X_K \ldots (11)$$

and equating like coefficients in (10) and (11), we have that

$$\beta_0^3 = \left(\beta_0^1 - \beta_0^2\right), \qquad \beta_1^3 = \left(\beta_1^1 - \beta_1^2\right),$$

$$\beta_2^3 = \left(\beta_2^1 - \beta_2^2\right), \ldots\ldots, \beta_K^3 = \left(\beta_K^1 - \beta_K^2\right)$$

Thus, for an independent variable with M levels regressed on K predictors, there are (M-1)(K+1) parameters to be estimated from the data.

The interpretation of coefficients in the multinomial logit model is very similar to the dichotomous case. For example, exp $\left(\beta_1^1\right)$ is the multiplicative factor by which the odds of being in category 1, versus category 3, changes for every unit increase in X_1, controlling for all other predictors, while exp $\left(\beta_1^2\right)$ is the multiplicative factor by which the odds of being in category 2, versus category 3, changes for each unit increase in X_1, controlling for all other predictors, and so forth.

In this study, the statistical software package STATA was used to calculate the multinomial logit model. The mlogit command was used to estimate a set of coefficients β^1, β^2, β^3, corresponding to the three outcome categories. The third category was arbitrarily set to 0. That is the software arbitrarily set $\beta^3 = 0$, the remaining coefficients

β^1 and β^2 would measure the change relative to the y=3 group. In other words, the third category was considered the base category and the remaining categories were interpreted in comparison to the third.

Model comparison and selection is based on the BIC statistic, which is best suited to large samples as in the present study. The BIC statistic originally derived from a Bayesian approach to statistical inference :

$$BIC = X^2 + p \log n \quad \ldots(12)$$

Where:

X^2 = the likelihood ratio test statistic for comparing the null model with no covariates with the model of interest

p = the number of independent variables in the model of interest (not counting the intercept) as defined by equation (12)

n= the sample size or number of cases in the logistic regression.

The smaller the BIC is, the better the model (Raftery et al. 1995)

Sources of Error

The reliability of mortality estimates calculated from retrospective birth histories like the present data depends upon the completeness with which deaths of children are reported and the extent to which birth dates and ages at deaths are accurately reported and recorded. Underreporting of deaths in early childhood, misreporting of the date of birth or age at death, especially for one particular gender are some of the major sources of error.

It has been well documented that ages are poorly reported in most parts of India. Ages are of little relevance to much of the rural population in particular, and no amount

of probing will ensure that ages are properly recorded. In interviewer training for the NFHS, a great deal of emphasis was placed on obtaining as accurate information as possible on ages and dates of events. Nevertheless, it is clear that age reporting in the NFHS shares the same problems inherent in all Indian censuses and surveys. Heaping on ages ending in 0 and 5 is severe, particularly in the older age groups and a pattern of heaping on ages ending in 2 and 8 is also evident. However, the NFHS age data are evidently of considerably better quality than the age data from other sources. This is clear, for example, by comparing the degree of age heaping in the NFHS with the 1981 census (IIPS 1995).

One traditional measure of the quality of data is the extent to which information is missing on key variables. Although completeness of responses does not necessarily indicate that the results are accurate, the existence of missing information for a large number of cases would suggest that the data collection was not carried out with sufficient care. For India as a whole, the extent of missing information is very low on all measures shown except for the measurement of the height and weight of young children. Another measure of data quality is the completeness and accuracy of information on births. Overall, for India, 98 percent of the living children listed in the birth history had complete birth dates recorded as did 92 percent of the children who had died. Thus, the completeness of data on birth dates is exceptionally good. Although the annual number of births does fluctuate somewhat, real annual fluctuations are to be expected and there is no evidence of the wholesale omission of births or displacement of birth dates, which would substantially affect the fertility rate estimates for recent years.

Another measure of completeness of reporting of births is the sex ratio at birth, which reflects the difference in completeness of reporting for male and female births. The expected sex ratio at birth is 107 or lower male births per 100 female births, and any tendency to omit female births would lead to a higher sex ratio. The sex ratio for all children ever born is 935 females for 1000 males, or 107 male births per 100 female births. This estimate is at the top of the expected range. There is no consistent trend in the sex ratio at birth by calendar year, and it does not exceed 107 males per 100 females for any of the five-year periods of the NFHS, suggesting that female births have not been grossly underreported in the NFHS. However, the reported sex ratio at birth for births that occurred more than 20 years before the survey (1971 or earlier) is 112, which suggests that underreporting of female births is likely during that early period. For data used in this study, the sex ratio has not exceeded 107 in any of the states, thereby indicating no underreporting of female births (IIPS 1995). The sex ratio at birth for the northern states of Uttar Pradesh and Haryana together is 973 female births per 1000 male births (live births). The sex ratio at birth for the southern states of Kerala and Tamil Nadu together is 1068 female births per 1000 male births (live births). Thus, in both cases, the ratio of expected births is much below the 107 mark.

Underreporting of infant deaths is another major source of error. Underreporting of infant deaths, in particular, is usually most severe for deaths which occur very early in infancy. If deaths in the early neonatal period are selectively underreported, then there will be an abnormally low ratio of deaths under seven days to all neonatal deaths and an abnormally low ratio of neonatal to infant deaths. Early infant deaths have not been severely underreported in the NFHS, since the ratios of deaths under 7 days to all

neonatal deaths are quite high (a ratio less than 25 percent is often used as a guideline to indicate underreporting of early neonatal deaths). The ratios decline slightly over time, from 70 in the five years preceding the survey to 66 in the period 10-14 years preceding the survey. Although there was no severe underreporting of deaths in the NFHS, there was some misreporting of age at death due to a preference for reporting the age at death at 3, 6, 8, 10, 12, 15, 20 and 25 days. However, this will not severely affect this study since all of these dates are coded as neonatal deaths within the scope of this study. The ratio of the percentages of infant deaths that occurred during the neonatal period are also quite high, suggesting that there is no major omission of early deaths. Moreover, there is a slight increase over time from 60 to 65, indicating that reporting of early infant deaths is most complete for the 5 years preceding the survey.

One problem that is inherent in most retrospective surveys is heaping of the age at death on certain digits, e.g., 6, 12 and 18 months. Misreporting of age at death will bias estimates of the age pattern of mortality if the net result of misreporting is the transference of deaths between age segments for which the rates are calculated; for example, an overestimate of child mortality relative to infant mortality may result if children dying during the first year of life are reported as having died at age 1 year or older. Thus, heaping at 12 months can bias the mortality estimates because a certain fraction of these deaths, which were reported to have occurred after infancy (i.e., at age 12-23 months), may have actually occurred during infancy (i.e., at the age 0-11 months). In this case, heaping would bias the infant mortality rate downward and the child mortality upward). Examination of the distribution of deaths under age two years during the 15 years prior to the survey by the month of death indicates that there is some heaping

of deaths at age 12 months, but few deaths were reported to have occurred at age 1 year. The calculated infant mortality rates for the country as a whole are not likely to be understated by more than 1-2 percent due to these types of age misreporting. For example, in the 5 years before the survey, even if the reported deaths at age 12 months were redistributed equally to 11, 12, and 13 months, and all of the deaths at age "1 year" were assumed to have occurred in the first year of life (which is an extreme assumption), then the infant mortality rate would increase by only 2 percent. Another point that needs mention is the fact that the method of data collection followed by the NFHS, i.e., interviewing mothers to get the birth histories of their children, will omit information on survivorship characteristics of infants and young children whose mothers died recently before the survey and thus will yield some understatement of the "true " rates of neonatal and postneonatal mortality 13 – 36 months before the survey.

IV. DISPARITIES IN INFANT MORTALITY

This chapter aims to provide an introduction to the general infant mortality pattern in India. The chapter focuses on (1) the levels of infant mortality in the states and districts in India, (2) inter-district variations in the levels of infant mortality and (3) gender disparities in infant mortality. A major objective of this chapter is to determine the infant mortality levels in the country, and identify patterns in the distribution of infant mortality. In this chapter, I discuss the magnitude of spatial inequalities in infant mortality in India, using various methods measuring spatial disparities. Disparities, in this study, are defined as an uneven distribution of infant deaths.

In the literature, regional disparities are analyzed using a variety of variables. Some use distribution of income per capita, wealth, or a combination of income or wealth as a measure of regional disparities (Smith 1982; Sommers, Mehretu, and Pigozzi 1996). Others use and develop indicators of well being, quality of life, or standards of living as a measure of regional disparities (Knox 1974; Kuz 1978; Schultink 1992). Most social scientists around the world now view the infant mortality rate as an excellent summary indicator of the socio economic development of a country (Jain and Visaria 1988). This study uses infant mortality as a measure of regional development and disparity. An attempt is made to examine the disparities in infant mortality between the states (macro spatial disparities) and the disparities within the states between districts (micro spatial disparities). These micro spatial disparities create micro-margins or small areas, which have high infant mortality rates and are dispersed within the states which according to aggregate measures are deemed as high or low mortality states. They are a reflection of

the magnitude of heterogeneity or internal variance within spatial units of analysis. Unlike most other studies dealing with infant/child mortality in India, where states are used as the unit of study, this study uses both states and districts as the spatial units of analysis.

Temporal Changes in Infant Mortality

To understand the present trend in infant mortality in India, it is necessary to have an idea of the historic changes in infant mortality. Table 4.1 shows the trends in infant mortality from 1901 to the present. Infant mortality in India was very high until 1921.

Table 4.1 Temporal Changes in Infant Mortality in India

Year	Infant Mortality Rate	Percentage Change
1901-1911	205.0	
1911-1921	211.5	+3.2
1921-1931	176	-16.8
1931-1941	167.7	-4.7
1941-1951	146.5	-12.6
1951-1961	139	-5.1
1972	139	
1981	110	-20.9
1991	80	-27.3
1992	79	-1.3

Source: The World Bank

The highest rate was recorded during the decade of 1911-21, which was mainly due to the influenza epidemic in the year 1918. A steady declining trend is noticeable since the 1930s. This trend in infant mortality conforms to the decline in general mortality. Over the last 2 decades, infant mortality in India has dropped significantly. The infant mortality rate for the total population of India declined from 110 deaths per 1000 births to 79 deaths per 1000 births in the period between 1981 and 1992 (IIPS 1995).

The National Family Health Survey estimates the infant mortality rates for the country at 79 deaths per 1000 live births. According to the methods used in this study, there are 76 infant deaths per 1000 live births in India. Table 4.2 shows the neonatal, postneonatal and infant mortality rates for the states in India, as determined in this study. There are some differences in the rates from these two sources. These differences can be explained by a comparison of the methods used to determine them (as explained in Chapter III). Similar differences were also observed when examining the male/ female differential in mortality. However, in this chapter, rates determined by the methods used in this research are used for analysis.

Disparities in Infant Mortality

To explore my first hypothesis, which states that there are significant regional variations in infant mortality in India, I aggregated individual mortality data to obtain the district figures. Infant mortality rates vary dramatically from one state to another ranging from 19 in Nagaland to 106 infant deaths per 1000 live births in Orissa, which has the highest infant mortality rate. Other states with infant mortality rates above the national average are Uttar Pradesh (100), Bihar (94), Madhya Pradesh (94) and Assam (89). The infant mortality rate is relatively low in Kerala (22), Mizoram (24) and Goa (20). Neonatal and postneonatal mortality rates show a similar regional trend. A majority of the northern states have infant mortality rates higher than the national average while the southern states have infant mortality rates lower than the national average.

Table 4.2 shows the infant mortality rates for the states in India and Table 4.3 shows lists the districts with highest and lowest infant mortality rates within the country.

Table 4.2
Neonatal, Postneonatal and Infant Mortality Rates in India

States	Mortality Rates		
	Neonatal Mortality	Postneon. Mortality	Infant Mortality
All India	44	32	76
North			
Bihar	53	42	94
Gujarat	44	36	79
Haryana	33	42	75
Himachal Pradesh	34	19	53
Jammu	34	15	49
Madhya Pradesh	55	40	94
Delhi	34	34	68
Punjab	30	27	56
Rajasthan	37	44	80
Uttar Pradesh	57	42	100
East			
Arunachal Pradesh	17	29	46
Assam	51	39	89
Manipur	24	18	42
Meghalaya	37	28	66
Mizoram	8	15	24
Nagaland	10	9	19
Orissa	61	45	106
Tripura	43	33	75
West Bengal	58	27	85
South			
Andhra Pradesh	47	24	71
Goa	17	3	20
Karnataka	45	20	65
Kerala	14	8	22
Maharashtra	33	18	51
Tamil Nadu	47	23	70

Table 4.3

Districts with Highest and Lowest Infant Mortality Rates

Districts that experienced some of the highest infant mortality rates (over 130 per 1000)	
States	**Districts**
Rajasthan	Ajmer, Dhaulpur
Madhya Pradesh	Ratlam, Shahdol, Satna, Damoh, Morena
Assam	Dhemaji, Karimganj
Bihar	Jehanabad, Muzaffarpur
Uttar Pradesh	Ghaziabad, Bareilly, Shahjahanpur, Rae Bareli, Jalaun, Bahraich
Orissa	Kendujhar, Puri
Maharashtra	Wardha
Himachal Pradesh	Lahul & Spiti
Districts that experience some of the lowest infant mortality rates (10 or fewer per 1000)	
States	**Districts**
Nagaland	Phek, Mokokchung
Arunachal Pradesh	East Siang, Upper Subansiri
Maharashtra	Bid
Karnataka	Hassan, Tumkur
Kerala	Kozhikode, Palakkad, Idukki
Tamil Nadu	Tiruchirapalli
Goa	North and South Goa
Gujarat	Rajkot
Rajasthan	Bharatpur
Bihar	Munger
Madhya Pradesh	Dewas, Raipur
Punjab	Kapurthala

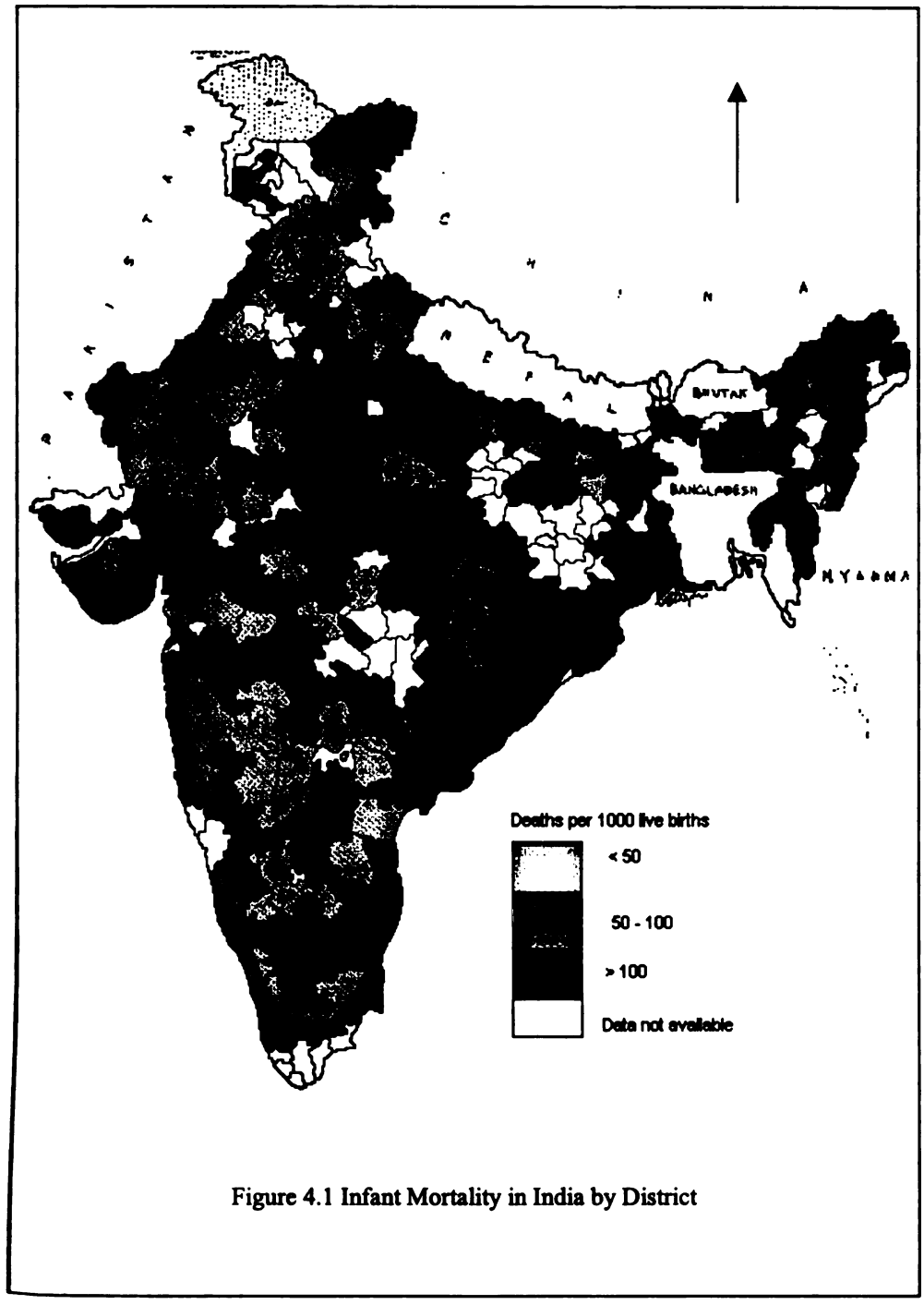


Figure 4.1 Infant Mortality in India by District

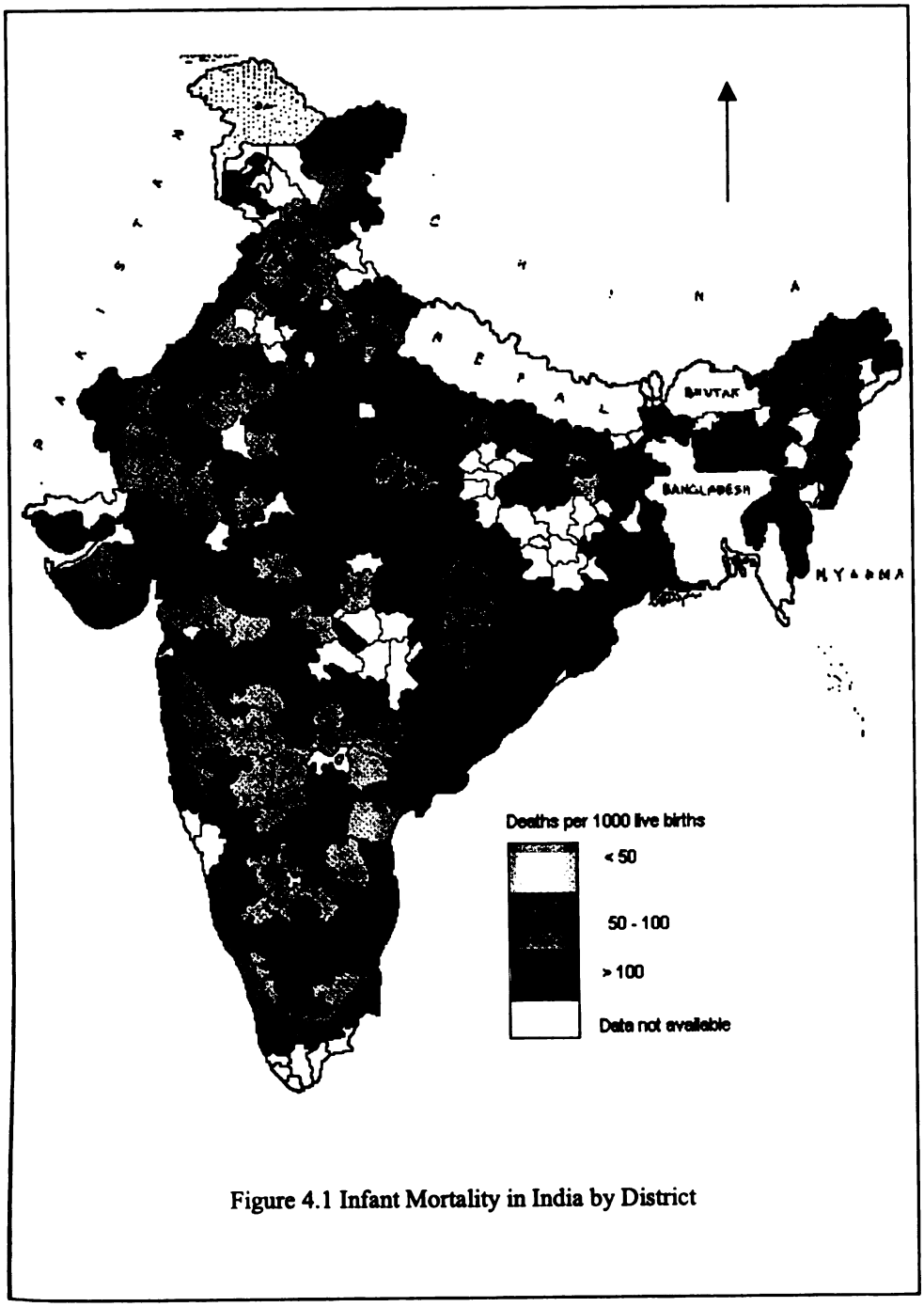


Figure 4.1 Infant Mortality in India by District

Figure 4.1 depicts the variations in infant mortality for the districts in India and clearly shows spatial patterns in the distribution of infant mortality. Spatial randomness with respect to the distribution of infant mortality can also be ruled out on the basis of previous research which helped to discern broad regional patterns in the distribution of infant/child mortality (Dyson and Moore 1983; Miller 1981; Murthi et al. 1995; Malhotra et al. 1995).

Figure 4.1 shows some distinct features regarding the levels of infant mortality in the country. These are: (1) The highest infant mortality levels are observed along a belt along the northwestern and north central parts of the country consisting of districts in Gujarat, Rajasthan, Uttar Pradesh, Bihar and Madhya Pradesh. Another area of high infant mortality is the coastal districts of Orissa and Andhra Pradesh. Other areas of high infant mortality include scattered areas in the eastern states of West Bengal and Assam. (2) Low infant mortality levels are observed mostly in an area starting from the base of the Deccan plateau toward the southern tip of the country and including most of Kerala, Karnataka, parts of Tamil Nadu and Andhra Pradesh. Other areas of low infant mortality include districts in the western and northeastern extremities of the country.

It is evident from Figure 4.1 that a mortality divide does indeed exist in India and that India exhibits not only great diversity, but also a distinct regional pattern where the north experiences much higher infant mortality rates than the south. Although, an in-depth analysis of the factors underlying these disparities is discussed in Chapter V, one can speculate, based on previous research and other published data, some probable causes behind these differences in infant mortality. It is important to point out that according to the published reports of the NFHS as well as census reports, the variation of female

literacy shows a regional pattern somewhat similar to the infant mortality pattern. Female literacy varies from more than 80 percent in Kerala and Mizoram to less than 30 percent in Rajasthan and Bihar. Despite the rapid gains that have been made in literacy and educational attainment over time in India, universal education is still far from a reality, more so in the northern and northwestern states. The lowest levels of school attendance were found in the states of Bihar and Rajasthan, where only about 40 percent of school-age females go to school. Fertility in India has also been declining over time. However, there are wide variations in fertility levels among the states. Fertility is considerably below the national average in South India (Andhra Pradesh, Karnataka, Kerala and Tamil Nadu) and West India (Goa, Gujarat and Maharashtra), where two states (Kerala and Goa) have already reached below-replacement fertility. At the other end of the spectrum, fertility is 4 children per woman or higher in Uttar Pradesh, Bihar, Haryana, and Arunachal Pradesh, and the total fertility rate (TFR) also exceeds the national average in Madhya Pradesh, Meghalaya, Rajasthan and Assam. With a TFR of 4.8, Uttar Pradesh stands out as having especially high fertility (more than 40 percent higher than the national average). Although current fertility is characterized by a substantial amount of early child bearing, most southern and western states indicate a higher age at the time of the birth of the first child. Goa stands out as a unique example with very low fertility before age 25.

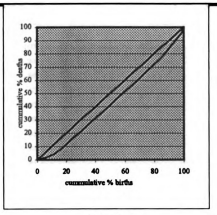
Spatial Patterns of Disparity in Infant Mortality

The distribution of infant mortality is assessed using Gini coefficients, Lorenz curves, location quotients and coefficient of variation. The Gini coefficient is a system measure in which it can describe the magnitude of the distribution with only using one

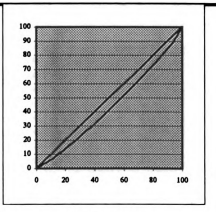
single coefficient. A value of the Gini coefficient ranges between 1 and 100. The value of Gini coefficient close to 0 indicates equal distribution and the value of Gini close to 100 indicates unequal distribution. The distribution can also been seen in the Lorenz curve in which the degree of inequality is shown by how far the Lorenz curve departs from the diagonal or equal share line (Smith 1982). The proportion of the total area between the diagonal and the Lorenz curve and the area below the diagonal is also a measure of the Gini coefficient. Since the Gini coefficient and Lorenz curve are system measures, the spatial concentration of specific components are measured using Location Quotients (LQs). Using the LQs, the concentration of the components in each district of the states can be compared. A value of LQ less than 1 indicates that the district's share is higher than that of the whole region. However, in this study mortality being a negative component, an LQ of more than 1 indicates a situation where mortality rates in the district in question is higher than the state. For the calculation of location quotients, infant deaths is used as the variable in question while the base variable is infant births. While in most cases population is a good base variable, in this case the use of population as a base variable would shield the differences in age structure in different areas. For instance, in some districts, where industrial development has been phenomenal, there might be a preponderance of young males. These districts might have very few infant deaths only because there are fewer infants living in that area. To avoid these confusions, number of births has been used as the base variable.

Table 4.4
Gini Ratios and Coefficients of Variation
Infant Mortality - India

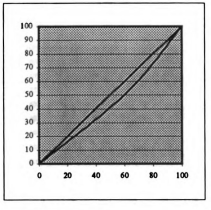
States	IMR	Gini ratio	Coefficient of variation
North			
Bihar	94	13.09	50.78
Gujarat	79	17.62	46.61
Haryana	75	14.40	31.33
Himachal Pradesh	53	10.35	35.01
Jammu	49	12.78	32.58
Madhya Pradesh	94	14.41	47.01
Punjab	56	9.45	40.49
Rajasthan	80	19.91	56.59
Uttar Pradesh	100	12.96	41.10
East			
Arunachal Pradesh	46	18.35	84.22
Assam	89	10.90	30.89
Manipur	42	8.06	65.86
Meghalaya	66	8.45	33.27
Mizoram	24	21.79	82.67
Nagaland	19	18.51	78.31
Orissa	106	12.19	33.30
Tripura	75	8.95	20.72
West Bengal	85	11.91	33.60
South			
Andhra Pradesh	71	16.75	45.42
Karnataka	65	16.00	60.01
Kerala	22	28.85	73.12
Maharashtra	51	18.02	51.72
Tamil Nadu	70	16.69	45.23



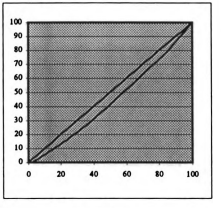
Manipur
Gini = 8.06
North



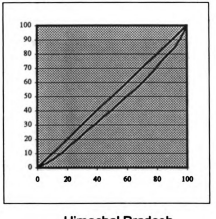
Meghalaya
Gini = 8.45
North



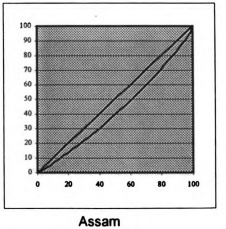
Tripura
Gini = 8.95
North



Punjab
Gini = 9.45
North

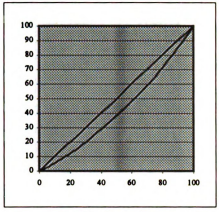


Himachal Pradesh
Gini = 10.35
North

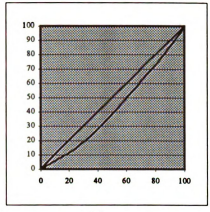


Assam
Gini = 10.90
North

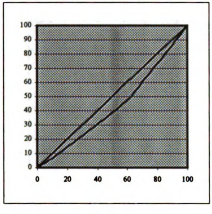
Figure 4.2 Lorenz Curves For The Distribution Of Infant Deaths In Relation To Births, By Districts Of The States



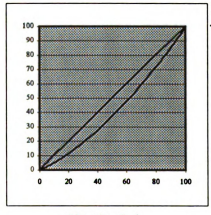
West Bengal
Gini = 11.91
North



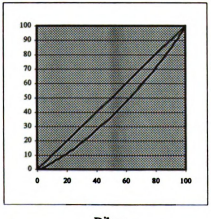
Orissa
Gini = 12.19
North



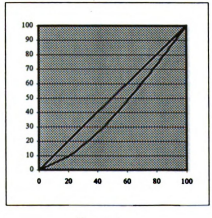
Jammu
Gini = 12.78
North



Uttar Pradesh
Gini = 12.96
North

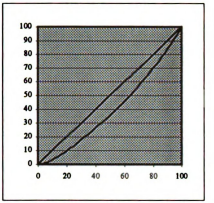


Bihar
Gini = 13.09
North

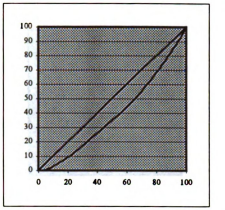


Haryana
Gini = 14.40
North

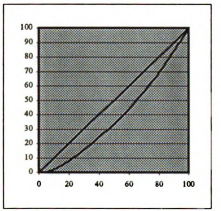
Figure 4.2 (cont'd)



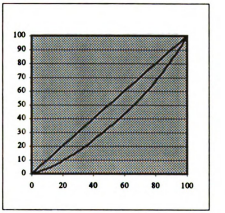
Madhya Pradesh
Gini = 14.41
North



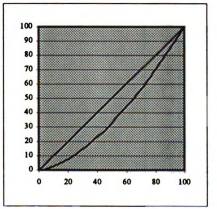
Karnataka
Gini = 16.00
South



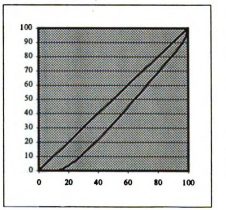
Tamil Nadu
Gini = 16.69
South



Andhra Pradesh
Gini = 16.75
South

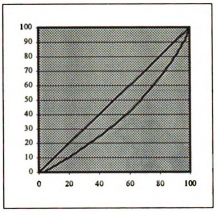


Gujarat
Gini = 17.62
South

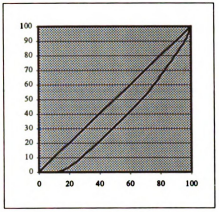


Arunachal Pradesh
Gini = 18.35
North

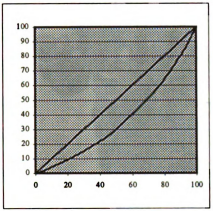
Figure 4.2 (cont'd)



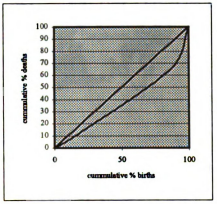
Maharashtra
Gini = 18.02
South



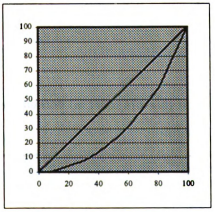
Nagaland
Gini = 18.51
North



Rajasthan
Gini = 19.91
North



Mizoram
Gini = 21.79
North



Kerala
Gini = 28.85
South

Figure 4.2 (cont'd)

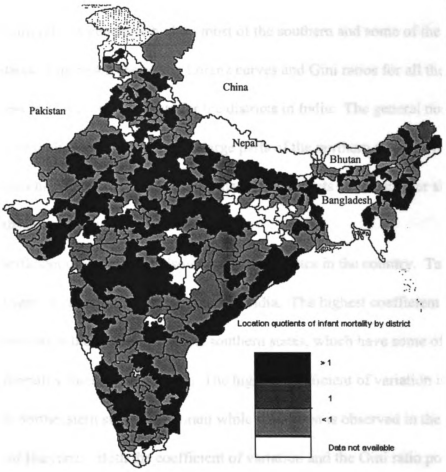


Figure 4.3 Location Quotients for Infant Mortality in India by District

Table 4.4 gives the Gini coefficient for each of the states in the country. The southern state of Kerala and North Eastern state of Mizoram have the highest Gini coefficient indicating that infant mortality is most unequally distributed in these states. Incidentally, except for Nagaland, these states also have the lowest infant mortality rates in the country. The Gini ratio is generally high in most of the southern and some of the northeastern states. Figure 4.2 shows the Lorenz curves and Gini ratios for all the states. Figure 4.3 shows the locations quotients for the districts in India. The general north south trend is visible from the map indicating that large parts of the northern states have location quotients higher than 1. This implies that these districts have a greater share of the infant deaths than expected.

The coefficient of variation is also calculated for states in the country. Table 4.4 lists the coefficient of variation for all the states in India. The highest coefficient of variation is observed in the north eastern and southern states, which have some of the lowest infant mortality rates in the country. The highest coefficient of variation is observed in the northeastern state of Mizoram while the lowest is observed in the northern state of Haryana. Both the coefficient of variation and the Gini ratio point toward the existence of internal variation in infant mortality within the states. Internal variation is higher in the states that have a generally low level of infant mortality as in the case of Kerala and Mizoram. These differences between districts within the states are an indication of micro-spatial disparities in infant mortality. For the southern state of Kerala, the district of Wayanad has 17 percent of the births during this period, but over 38 percent of the infant deaths, thereby having a location quotient of 2.21. On the other hand, the district of Kottayam, which has the lowest location quotient, has 7 percent of

the births and less than 1 percent of the infant deaths. Incidentally, Wayanad is located in the highland regions of Kerala at a height of 700 to 2100 meters above sea level and has the highest concentration of aboriginal population belonging to various tribes who are economically and socially disadvantaged. On the other hand, Kottayam is located in the foothills of the Western Ghats and has some important trading centers especially for plantation crops like rubber, tea, pepper and cardamom. Perhaps, the most important difference between these two districts is the fact that Kottayam is a stronghold of the Christian community in the state and many denominations of this faith have their headquarters in this district. The educational level of the people of this district is also generally high as is evident from the number of newspapers and magazines that are published in English and Malayalam (the state language) from this district.

Compared to Kerala, the northern state of Uttar Pradesh on the hand exhibits a more equitable distribution of infant deaths within the districts. In the northern state of Uttar Pradesh, 47 out of the 54 districts for which data were available have infant mortality rates of over 50, while 27 have infant mortality rates above 100. Hence most of Uttar Pradesh experiences high birth and infant death rates. Only one district (Pithoragarh) in the state of Uttar Pradesh has an infant mortality rate of less than 30 infant deaths per 1000 live births. Pithoragarh is one of the Himalayan districts which is sparsely populated and most of the permanent population in this district consists of people living in 'ashrams' (Hindu monasteries). Several of these "ashrams" run their own schools and dispensaries and help in up lifting the general health of the population.

Female Disadvantage

To determine the gender disparity in the mortality rates, the ratio of male to female mortality rates have been measured. Because male mortality as a result of daughter preference is rare, the result of the ratio can be unambiguously interpreted: the lower the value of the ratio the higher the discrimination against females, and thus the greater the gender inequality in infant mortality. Table 4.5 shows the male/female ratios of the neonatal, postneonatal and infant mortality rates for the states in India. A female disadvantage in mortality during the first year of life is evident in the states of Gujarat, Haryana, Rajasthan, Uttar Pradesh, Tripura and West Bengal. During the neonatal period, when the biological advantage of female infants over male infants is supposed to be at the highest level, females still experience higher mortality compared to males in the northern states of Haryana, Rajasthan, Uttar Pradesh and Gujarat. During the postneonatal period this disadvantage extends to all the northern states, and some southern and northeastern states. This higher female mortality rate as compared to the males during infancy contradicts the biological expectation of better survival chances for the female infant. In India it is evident that a female disadvantage in survival starts during the neonatal period in some of the northern states and extends to all the northern and some southern and northeastern states by the postneonatal stage of life. Female disadvantage in survival is stronger after the neonatal period because during the former environmental, social and cultural factors replace the biological factors that are more important during the neonatal period.

For instance, the impact of medical care during the pregnancy and also at birth and the physical health of the mother can be expected to have a greater impact on the survival chances of the infant during the neonatal period. Figure 4.4 shows the gender differentials in infant mortality in India by district and identifies those districts that experience a disadvantage in female mortality. It is evident from the map that female disadvantage is highly concentrated in the northern and northwestern parts of the country. This trend reiterates the point the work of several social scientists has established that a highly differential female infant and child mortality pattern is evident between the north and the south and can perhaps be traceable to ideological factors responsible for this peculiarly sub-continental phenomenon. The line that separates the high female disadvantage in districts from those with relatively equitable mortality rates for males and females approximates and extends along the line of the Satpura hill range. As observed by Dyson and Moore (1983), the Narmada River, which closely follows the Satpura range, marks the boundary between north and south India in classical Brahmainic writings. The degree of freedom for women on the southern side of this line has been observed since the pre-Christian era. Ethnographic studies and aggregate data from past censuses have been used to show a rough but long-standing regional divide in key features of kinship and gender survival. While the historical reasons are not fully clear, the general inference is that possibly because of matrilineal influences, the cultural divide between Dravidians and Aryans, and the prevalence of labor-intensive wet-rice cultivation – women in the south are in a better situation than those in the north.

Table 4.5
Male Female Differentials in Infant Mortality

States	Mortality Rates						Mortality Ratios		
	Male			Female			Male/Female		
	Neonatal	Post neonatal	Infant	Neonatal	Post neonatal	Infant	Neonatal	Post neonatal	Infant
North									
Bihar	57	38	95	48	45	92	1.19	**0.84**	1.03
Gujarat	42	30	72	45	41	86	**0.93**	**0.73**	**0.84**
Haryana	30	28	58	36	56	92	**0.83**	**0.50**	**0.63**
Himachal Pradesh	44	17	61	24	21	45	1.83	**0.81**	1.36
Jammu	37	14	51	31	15	47	1.19	**0.93**	1.09
Madhya Pradesh	60	34	94	49	45	94	1.22	**0.76**	1.00
Delhi	38	33	71	29	35	64	1.31	**0.94**	1.11
Punjab	33	23	56	26	30	56	1.27	**0.77**	1.00
Rajasthan	35	34	69	38	53	91	**0.92**	**0.64**	**0.76**
Uttar Pradesh	55	40	95	59	44	104	**0.93**	**0.91**	**0.91**
East									
Arunachal Pradesh	26	24	50	8	33	41	3.25	**0.73**	1.22
Assam	53	42	95	49	35	83	1.08	1.20	1.14
Manipur	27	24	52	20	12	32	1.35	2.00	1.63
Meghalaya	43	30	74	31	26	57	1.39	1.15	1.30
Mizoram	13	13	26	3	17	21	4.33	**0.76**	1.24
Nagaland	12	17	30	8	0	8	1.50		3.75
Orissa	66	45	112	55	45	100	1.20	1.00	1.12
Tripura	43	29	72	42	36	78	1.02	**0.81**	**0.92**
West Bengal	58	19	77	57	35	92	1.02	**0.54**	**0.84**
South									
Andhra Pradesh	53	19	72	41	29	70	1.29	**0.66**	1.03
Goa	25	6	32	8	N/A	N/A	3.13	N/A	N/A
Karnataka	57	17	74	33	22	56	1.73	**0.77**	1.32
Kerala	16	7	23	12	9	21	1.33	**0.78**	1.10
Maharashtra	42	17	59	24	18	42	1.75	**0.94**	1.40
Tamil Nadu	57	24	81	37	22	59	1.54	1.09	1.37

Bold font indicates female disadvantage.

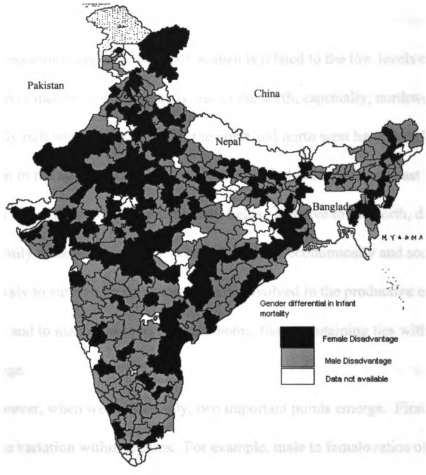


Figure 4.4 Male Female Differential in Infant Mortality in India by District

The kinship system prevalent in the north is characterized by the practice of patrilocal exogamy and gives exclusivity to males in social, political and economic cooperation, in the fulfillment of religious obligations, and intergenerational transfer of fixed assets. This kind of kinship system largely results in the undervaluation of women in the north.

The economic undervaluation of women is related to the low levels of women's participation in income generating activities in the north, especially, northwest. The agriculturally rich wheat based states of the north and north west have very low female participation in the agricultural fields, while the paddy based south and east have high percentages of women working on the paddy fields. Relative to the north, daughters in southern family systems are seen as more valued, both economically and socially; they are more likely to survive, to be educated, to be involved in the productive economy, to marry later, and to marry closer to the natal home, thus maintaining ties with parents even after marriage.

However, when we look closely, two important points emerge. First, there is considerable variation within regions. For example, male to female ratios of infant mortality are over 1 in some of the hill districts of Northern India despite the general pattern of high female disadvantage in infant mortality. This can perhaps be explained by the fact that in these hilly, economically depressed areas, women play a major role by bringing in firewood and often times water for the household. Furthermore, these hilly areas in the north have very little participation in the dowry system. These factors relatively improve the economic status of women in these households as compared to the general situation in the north. Miller (1981) in an ethnographic study of the Himalayan

region of India has indicated that the Gaddis, a local ethnic group, of Goshen village of Chamba district in the northern hill region, give special snacks to girls and that girls are certainly not discriminated against in terms of food. This is a noteworthy aberration from the pattern evident in the northern plains. It is perhaps no mere coincidence that favoritism toward girls in food distribution is found in Chamba district where survival for girls is also high. Thus the Himalayan region, while geographically northern, is in some cultural ways more akin to the south. In the south, some pockets show evidence of female disadvantage, in contrast to the evidence for relatively better female survival in the region overall.

Second, some interesting geographic patterns other than the North-South differential also emerge. One of the most striking is the differential between coastal districts (and occasionally frontier districts) and interior districts. For example, we clearly see a more favorable situation for women in the coastal districts of the southwest with regard to infant mortality gender ratios. Incidentally these are major areas of labor-intensive wet rice cultivation where women play a major role in agricultural production especially during planting and harvest. These areas are also major producers of cotton and coffee where women's labor is involved during the picking season. Moreover, an East –West differential seems to be prominent in addition to the north south divide. Many northeastern ethnic groups, like the Khasis, follow a matrilineal family system. Furthermore, these states have been greatly influenced by the Christian missionaries who have been visiting India since the British period. In fact, Christians comprise over 95 percent of the population of Mizoram, 93 percent of Nagaland, and 76 percent of

Meghalaya. This preponderance of Christians in these states helps to minimize or often eliminate the social and cultural practices that lower status of women in the north.

Conclusions

In this chapter, I have addressed the issue of spatial and gender disparities in infant mortality in India by using district-level data from the National Family Health Survey, 1992. This data set has allowed me to identify regional patterns of disparity in infant mortality. Three conclusions emerge from this analysis. (1) First, there are macro as well as micro disparities in infant mortality in India. (2) Second, micro disparities or disparities in infant mortality between districts are higher in the south and northeast, among states that have a generally low infant mortality rates. (3) Third, gender disparities in infant mortality exhibit an expected north south trend where the southern female infants are better off than the northern female infants. However, the very fact that in some southern states, female mortality rates are higher than male mortality rate is indicative of a certain level of bias against the female infant. In fact, a gender bias in favor of male infants is embedded in Indian society but there is a definite preponderance of this bias in the north. India has long been characterized by a major north/south dichotomy with regard to the survival of female infants. This finding reiterates the finding of other earlier studies on gender differentials in infant and child mortality in India. There is considerable documentation that culture in India exhibits not only great diversity, but also a distinct regional pattern (Sopher 1980; Miller 1981). The variation according to many scholars of India, is most pronounced with regard to female survival as it relates to women's status, and can be roughly delineated along geographic lines: areas in the north are culturally less favorable to female autonomy than areas in the south

and the east. However, there seems to be a greater complexity to the North-South dichotomy than suggested by existing literature. In addition to the general pattern that divides the country into the north and the south, these regions exhibit some level of internal variations. The Himalayan region stands out as area that in some way resembles the south with regard to infant mortality pattern. These results suggest that relation between gender and infant mortality is multi-dimensional in nature and any study that relates them must incorporate economic, geographic, social and cultural factors.

V. DETERMINANTS OF INFANT MORTALITY

One important aspect of this research is to explain infant mortality variations by gender and location. The purpose of this chapter is therefore to explore the relation between gender sensitive mortality and various socioeconomic, geographical, cultural, demographic and medical factors. The chapter is divided into two sections beginning with a general description of the data followed by a discussion of the results from the regression analyses. In this chapter, the states of Kerala and Tamil Nadu from the south, and Uttar Pradesh and Haryana from the north, are used for comparing regional differences that typify the Indian sub-continent.

The data are grouped into two, namely (1) all children born 13-36 months prior to the survey and (2) those that are "last births" during the 13 to 36 months prior to the survey. This grouping has enabled the use of the variable indicating breast-feeding in two different ways in the analysis. For all children born 13 to 36 months prior to the survey, breast feeding is entered into the multinomial logit regression as a 1/0 dummy indicating only whether the infant was breast fed or not. For last births the variable was expanded to include the time and manner in which the child was breast-fed.

Table 5.1 shows some noteworthy differences in the characteristics between the northern and the southern study states. The cases with missing data on variables dealing with distance from health centers were omitted since they were less than 5 percent of the total number of cases.

Table 5.1

Percentages of infants showing various characteristics (used as independent variables)

Variables	North	South	Variables	North	South
Infants			**Childcare**		
NeonatalDeaths	6.2	1.8	mother only	83.7	76.5
Postneonatal Deaths	4	1.7	additional caregiver	16.3	23.5
Living	89.8	96.5	**Caste**		
Gender			general	21.3	13.8
Male	50.7	48.3	scheduled castes	1.7	2.8
Female	49.3	51.7	scheduled tribes	77.1	83.4
GenPrev			**Religion**		
First Birth	20.9	34.1	Hinduism	86.2	69.8
Male	40.1	31.4	Islam	11.7	19.6
Female	39	34.5	Christianity	1.2	10.5
Gender Composition of Siblings			Sikhism	0.8	0.1
Premale/Prefem			**Prior relation between parents**		
No male/No female	36.5	61	Parents related prior to marriage	11.4	29.7
1 male/1female	38	27.5	Parents not related prior to marriage	88.6	70.3
2 -3 male/ 2-3 female	22	10.3	**Housing Facility Index**		
4 or more male/ 4 or more female	3.46	1.2	less than half of the amenities	85.3	62.6
Prefem			**Irrigated land**		
No female	44.5	58.2	No irrigated land or less than 1 acre	54.1	92.3
1female	29.2	30.4	50 or more acres	0.3	0.9
2-3 female	22.7	10.4	**Non irrigated land**		
4 or more female	3.6	1.1	No land or less than an acre	86.4	84.7
Birthorder			**Household commodities owned**		
First Birth	20.9	34.1	None	18.3	25.5
Parity 2 and3	37.6	52.3	Less than half	77.7	69.5
Parity 4 or above	41.5	13.6	**Prebirth Medical Index**		
Birth Interval			No medical examination	53.9	4.8
First Births or interval=>24 months	76.8	84.5	Less than half of the requirements	31	64.1
<24 months	23.2	15.5			

Table 5.1 (cont'd)

Variables	North	South	Variables	North	South
Age of mother (Agem)			**Birth Medical Index**		
<20	16.1	15.2	Less than half of the requirements	23.6	14.1
20 - 34	74.4	80.4	All of the requirements	0	2.2
>35	9.4	4.4	**Breast feeding**		
Mother's Education(4 categories)			Breastfed	95.5	97.1
illiterate	82.1	35.7	Not Breastfed	4.5	2.9
literate-primary	9.5	30	**Distance**		
middle complete	4.4	18.5	*to water (time)*		
High School plus	4	15.8	in the house	42.8	40.8
Mother's Education(6 categories)			15 minutes or more	27.7	26.2
illiterate	82.1	35.7	*to nearest town*		
literate-primary incomplete	1.5	9.1	under 5 Kms.	7	39.1
primary complete	8	21	*to Subsidiary Health Center (SC)*		
middle school complete	4.4	18.5	0 Kms.	19.3	58
High School complete	3.5	11.9	5 Kms. Or more	56	27.9
University	0.5	3.8	*to Primary Health Center (PHC)*		
(Mother's Occupation 4 categories)			0Kms.	6	39.1
Not working	76.1	65.9	5 Kms. Or more	83	48
works for family member	17.1	4.3	*to Government Hospital (HC)*		
works for someone else	4.5	27.3	0 Kms.	8.6	50.9
self=employed	2.3	2.6	5 Kms. Or more	73	33.3
(Mother's Occupation 3 categories)			*to nearest Health Center*		
Not working	76.1	65.9	0 Kms.	25.7	64.5
earns cash for work	7.8	29.6	5 Kms. Or more	47	17.5

Although the sex ratio at birth for this period for both regions falls within the expected range of 90-105, the southern states exhibit a situation more favorable to females. Southern infants, both male and female have a better survival record than the northern infants. The breakup of infant cases according to birth order shows some glaring differences between the northern and the southern states. For example, while only over 13 percent of the southern cases belong to birth orders 4 and higher, over 40 percent of the northern infants belong to this category (the first born child is considered as birth order 1).

The cultural differences between the north and the south are evident from a comparison of the religious and caste differences between these regions. While over 85 percent of the northern infants are Hindus, only about 70 percent of southern infants belong to this group. Christians constitute over 10 percent of southern infants compared to only 1 percent in the north. For both the northern and the southern states, there is a preponderance of infants belonging to the scheduled castes and tribes. This is a result of the systematic sampling procedure to include the scheduled tribes and thereby reduce the chances of a selection bias that could result in a lack of cases from these groups. About 30 percent of southern infants belong to parents who were in some way related by blood while only 11 percent of northern infants belong to this category.

Perhaps one of the greatest differences between the north and the south is evident from the differences in the educational characteristics of the mothers. The percent of illiterate mothers in the south is less than half that in the north. Most of the northern working mothers work for relatives and do not earn any cash. The other differences between the north and the south are evident from the medical and distance variables. The

pre-birth medical index (which is a combination of factors determining medical attention prior to birth, as explained in Chapter III) indicates that less that 5 percent of southern mothers had no medical care during pregnancy as compared to a massive 53 percent in the northern states. However, the scene is more equitable with regard to the birth medical index (a combination of medical factors at the time of birth, as explained in chapter III) and breast-feeding.

Access to medical facilities greatly differs between the north and the south. Almost 65 percent of the southern infants have some form of medical facility in their village itself while only about 26 percent of the northern infants have a facility within the village. For over 45 percent of northern villages, the nearest health center is 5 or more kilometers away from the village while less than 18 percent of the villages in the south are 5 or more kilometers away from a health center. While only over 8 percent of north Indian villages have a hospital (H) in the village, over 50 percent of southern villages do. Only 6 percent of northern villages have a Primary Health Center (PHC) compared to almost 40 percent of southern villages. Less than 20 percent of northern villages have a subsidiary health center (SHC) while almost 60 percent of southern villages do. The southern villages are closer to an urban center than the northern villages.

Bivariate Analysis of Neonatal and Postneonatal Mortality in Northern and Southern India

To see to what extent the independent variables affect infant survival, bivariate associations are examined followed by multivariate analyses controlling for all relevant factors. The results of the bivariate analysis are shown in two separate tables for the northern and the southern states.

Table 5. 2
Selected Bivariate Results for Infants in the Northern States

	All Births			Last Births		
Factors	Neonatal Mortality	Post neon. Mortality	BIC	Neonatal Mortality	Post neon. Mortality	BIC
Breastfeeding	N/A	N/A	N/A	-2.0992***	-.3513**	-255.9526
Birth Medical Index	-.9118***	-.3342***	-93.06	-.8472***	-.1937	-19.7126
Prebirth Medical Index	-.2103***	-.1593***	-21.81	-.2107***	-.1279**	-.7826
Number of surviving male siblings	-.5301***	0.1142	-15.14	-.8432***	.1237	-15.9826
Childcare	-1.0094***	-.6054**	-3.42	-1.4829***	-1.0268**	-3.4026
Birth interval	.3139**	.7692***	-1.01	N/A	N/A	N/A
mother's age	-.6053***	-.1489	-.65	N/A	N/A	N/A

***** p<.01; ** p<.05; * p<.10**
survival to first birthday is the omitted category or comparison group.

Table 5.3 a
Selected Bivariate Results for Male Infants in the Northern States

	All Births			Last Births		
Factors	Neonatal Mortality	Post neon. Mortality	BIC	Neonatal Mortality	Post neon. Mortality	BIC
Breastfeeding	N/A	N/A	N/A	-2.1154***	-.2338	-111.9305
Birth Medical Index	-1.0170***	-.5171***	-56.8389	-.8891***	.3960	-4.4105
Prebirth Medical Index	-.1882***	-.3334***	-12.5289	-.2590***	-.2958**	-.9805
Number of surviving male siblings	-.7418***	.1177	-10.5289	-1.2561***	-.1379	-10.9105

***** p<.01; ** p<.05; * p<.10**
survival to first birthday is the omitted category or comparison group

Table 5.3 b
Selected Bivariate Results for Female Infants in the Northern States

	All Births			Last Births		
Factors	Neonatal Mortality	Post neon. Mortality	BIC	Neonatal Mortality	Post neon. Mortality	BIC
Breastfeeding	N/A	N/A	N/A	-2.0905***	-.4289**	-131.1886
Birth Medical Index	-.8068***	-.1859	-25.6540	-.8046***	-.0558	-3.1886
Prebirth Medical Index	-.2319***	-.0573	-2.5640	-	-	-
Childcare	-1.1492***	-.9749**	-.2440	-1.1603**	-2.1848**	-.4686

***** p<.01; ** p<.05; * p<.10**
survival to first birthday is the omitted category or comparison group

Table 5.4

Selected Bivariate results for infants in the Southern states

	All Births			Last Births		
Factors	Neonatal Mortality	Post neon. Mortality	BIC	Neonatal Mortality	Post neon. Mortality	BIC
Breastfeeding	-5.4895***	-2.3649***	-72.9404	-1.4566***	-.0362	-.1384
Birth Medical Index	-.9059***	-.6187***	-13.3804	-1.4876***	-.6734**	-2.5284

*** p<.01; ** p<.05; * p<.10

survival to first birthday is the omitted category or comparison group

Table 5.5 a

Selected Bivariate Results for Males Infants in Southern States

	All Births		
Factors	Neonatal Mortality	Post neon. Mortality	BIC
Breastfeeding	-5.3589***		-36.5338
Birth Medical Index	-1.1939***	-.8092**	-4.9838

*** p<.01; ** p<.05; * p<.10

survival to first birthday is the omitted category or comparison group

Table 5.5 b

Selected Bivariate Results for Female Infants in the Southern States

	All Births			Last Births		
Factors	Neonatal Mortality	Postneon Mortality	BIC	Neonatal Mortality	Postneon. Mortality	BIC
Breastfeeding	-5.806***	-4.3588***	-31.4217	-1.6679***	-1.1945***	-.4424
Birth Medical Index	-.8620***	-.5611	-.7017	-2.4549***	-.5494	-.0924

*** p<.01; ** p<.05; * p<.10

survival to first birthday is the omitted category or comparison group

The bivariate analyses (Tables 5.2 and 5.4) reveal significantly higher chances of infant survival in the north as well as south, among children who are breast-fed and those who have had medical care at the time of birth. These factors have the largest impact on both male and female infant survival in the northern and southern study states (Tables 5.3 and 5.5). Northern infants also benefit from other factors. For instance, having a higher number of older male siblings improves male survival during the neonatal period (Table 5.3a). Availability of caregivers in addition to the mother improves female survival during the neonatal as well as postneonatal period (Table 5.3b).

Multivariate Results

In order to study the relation between infant survival and the independent variables, multinomial logit models were run for all infants and for male and female infants separately for the northern and southern study states. I started by fitting a multinomial logit model with all the possible variables of interest and then removing those variables that are not statistically significant for any category of the polychotomous dependent variable and those that do not even approach statistical significance. I present here the fullest models (with the longest list of predictors) and the simplest model (with the shortest list) with the lowest BIC, so that it is easier to explain which of the variables have been examined and discarded. I used the BIC statistic for model comparison and selection. In the following section, I present the results of the multivariate analyses and discuss the important results.

For the northern states, breast feeding could not be used as a variable for the group consisting of all infants born 13 – 36 months prior to the survey due to data limitations (the lack of cases that were not breast-fed). The analysis and discussion is

based on the group consisting of infants who are last births among the children born 13 – 36 months prior to the survey. However, for the south, only the first group of infants consisting of all infants born 13-36 months prior to the survey is used for the analysis and discussion, due to the lack of valid cases for some of the variables in the other group. Hence, for the southern models, breast-feeding could only be used as a dichotomous variable indicating whether the child was breast-fed or not, instead of the elaborate breast feeding index which was used for the northern models.

The initial model for the north has a BIC of 33.8389 while that of the south has a BIC of 209.34. Tables 5.6 and 5.9 show the variables and their coefficients for these models respectively. The smaller the BIC and the more negative the BIC, the better the model. For the model with no covariates, the BIC is 0, so a positive BIC indicates a model that is worse than the null model. In order to determine the most parsimonious model, I selected those variables that are statistically significant for at least one category of the polychotomous dependent variable. The BIC statistic for the final model for the north improves to be –218.5437, while that for the southern model improves to –35.0718 (Tables 5.6 and 5.9). This indicates that the northern model has a better fit than the southern model.

Breast feeding and medical care at the time of birth enhances the odds of survival for northern as well as southern infants. For northern infants, quantity of household goods owned, medical care throughout the pregnancy, child care in addition to that of the mother, caste, region of residence (infants in Haryana have higher chances of survival) and number of surviving older male siblings significantly impact infant survival.

Table 5.6

Multinomial Logit Regression Coefficients for Neonatal and Post Neonatal Mortality in Northern India among Latest Births 13-36 Months prior to the Survey

	Initial model			Final Model	
Number of cases	2284		Number of cases	2284	
BIC	33.8389		BIC	-218.5437	
Log Likelihood	-454.65993		Log Likelihood	-467.67386	
Degrees of freedom	54		Degrees of freedom	18	
Variables	**Neonatal**	**Postneonatal**	**Variables**	**Neonatal**	**Postneonatal**
Gender of previous birth	-.4423	-.4265	Household goods index	-3.5786***	0.8791
Birth order	0.4818	0.4468	Child care	-1.4977**	-1.1283**
Birth interval	0.5478	0.6595**	Pre-birth medical index	-.1997***	-.1435**
Household goods index	-3.2474**	0.819	Birth medical index	-.6524***	-.1662
Child care	-1.7081**	-1.5110***	Breast feeding index	-2.830***	-.3199*
Mother's occupation	0.1448	0.3033	Caste	-.0753	-.4691***
Housing facility index	-.0480	0.0837	Region	.1913***	0.0924
Non irrigated land	-0.0702	-.0765	Number of older male siblings	-.8631***	0.1061
Pre-birth medical index	-.1761**	-.1325*			
Birth medical index	-.6727***	-.1697			
Breast feeding index	-2.0939***	-.3392*			
Mother's education	0.0092	-.0742			
Caste	0.0076	-.4557***			
Distance to water	0.0098	0.0023			
Religion	-.4239	-.3395			
Type of marriage	0.027	-.4868			
Distance to PHC	0.0034	0.0076			
Distance to H	0.0031	-.0070			
Distance to SC	-.0206	-.0196			
Distance to town	-.0004	0.0046			
Region	.1831**	0.0613			
Mother's age at birth	-.066686	0.106			
Distance to nearest health center	0.0285	0.0182			
Level of nearest health center	0.0734	-.0544			
Number of older male siblings	-1.0692***	-.1035			
Number of older female siblings	-.1487	-.0600			

***** p<.01; ** p<.05; * p<.10**

survival to first birthday is the omitted category or comparison group

Table 5. 7

Multinomial Logit Regression Coefficients for Male Neonatal And Post Neonatal mortality in North India among latest births 13-36 months prior to the survey

	Initial model		Final Model	
Number of cases	1170		1170	
BIC	157.4175		-69.9639	
Log Likelihood	-179.6493		-193.12307	
Degrees of freedom	52		16	
Variables	**Neonatal**	**Postneonatal**	**Neonatal**	**Postneonatal**
Gender of previous birth	-.01112	.9426**	-.1609	-.8858**
Birth order	-.1277	.8925*	-.0494	.8464**
Pre-birth medical index	-.3645**	-.3405***	-.3341***	-.3346***
Birth medical index	-1.0610***	-.4377	-1.0150***	-.4334
Breast feeding index	-2.2652***	-.1802	-2.1984***	-.1715
Distance to SC	-.1556*	-.0289	-.1352**	-.0259
Distance to nearest health center	0.2021	-.0042	.13324**	--.0236
Number of older male siblings	-1.5579***	-.7421**	-1.5523***	-.6463**
Birth interval	0.1078	0.7454		
Ownership of household goods	-3.5254	-2.2364		
Child care	-2.0322	-.8498		
Mother's occupation	0.5037	0.4642		
Housing facility index	-.0250	0.0073		
Irrigated land	-.1310	-.0117		
Mother's education	0.1272	0.1444		
Caste	0.0925	-.0179		
Religion	-.6294	-.0073		
Distance to water	0.0016	-.0136		
Type of marriage	-1.1925*	0.4277		
Distance to PHC	-.0105	-.0058		
Distance to H	-.0183	0.0104		
Distance to town	-.0143	.0107		
Region	0.1637	0.1031		
Mother's age at birth	0.0067	-.0096		
Level of nearest health center	-.0854	-.0624		
Number of older female siblings	-.2551	-.1486		

***** p<.01; ** p<.05; * p<.10**

survival to first birthday is the omitted category or comparison group

Table 5. 8

Multinomial Logit Regression Coefficients for Female Neonatal and Postneonatal mortality in North India among Latest Births 13-36 months prior to the Survey

	Initial model		Final Model	
Number of cases	1114		1114	
BIC	134.907		-98.9500	
Log Likelihood	-244.19891		-260.56941	
Degrees of freedom	52		14	
Variables	**Neonatal**	**Postneonatal**	**Neonatal**	**Postneonatal**
Birth medical index	-.4635*	0.033	-.4692*	0.0103
Breast feeding index	-2.1556***	-.4178*	-2.1030***	-.3157
Caste	0.0983	-.7888***	-.0665	-.8243***
irrigated land	-.0260	.0549*	-.0554	.0686***
Type of marriage	1.1718	-.9012*	1.2345*	-.7871*
Number of older male siblings	-.8566**	0.3119	-.4064*	.3427*
Child care	-1.4922	-2.6957**	1.2682	-2.2132**
Gender of previous birth	-.7469*	-.1580		
Birth order	0.817	0.0639		
Birth interval	0.7365	0.5984		
Ownership of household goods	-2.2266	1.0625		
Mother's occupation	0.125	0.3189		
Housing facility index	-.0921	0.1196		
Pre-birth medical index	-.0929	0.0009		
Mother's education	-.0091	-.2634		
Religion	-.2989	-.6281		
Distance to water	0.0154	0.008		
Distanc to PHC	0.01	0.0165		
Distance to H	0.0061	-.0216		
Distance to SC	0.0103	-.0236		
Distance to town	0.0022	0.0001		
Region	0.1662	0.0449		
Mother's age at birth	0.0183	0.1642		
Distance to nearest health center	-.0088	0.0335		
Level of nearest health center	0.1025	-.0227		
Number of older female siblings	-.1743	-.0236		

***** p<.01; ** p<.05; * p<.10**

survival to first birthday is the omitted category or comparison group

Table 5. 9

Multinomial Logit Regression Coefficients for Neonatal and Post Neonatal mortality in South India for All Births 13-36 Months prior to the Survey

	Initial model		Final Model	
Number of cases	939		939	
BIC	209.34		-35.0718	
Log Likelihood	-85.62513		-114.00501	
Degrees of freedom	54		10	
Variables	**Neonatal**	**Postneonatal**	**Neonatal**	**Postneonatal**
Gender	-.5050	-1.4051**	-.2546	-1.0332**
Birth medical index	-.3003	-.6703**	-.2514	-.6432***
Breast feeding	-7.7992***	-1.7063	-5.2878***	-1.1979
Mother's education	-.6303	.78597**	.4009	.4438**
Type of marriage	-.0959	-1.4725**	0.4114	-.8892*
Birth order	.1138	1.5925		
Birth interval	0.407	0.2561		
Gender of previous birth	0.4195	0.2374		
Ownership of household goods	-2.5457	-2.6662		
Housing facility index	-.4880	0.0484		
Child care	-42.5439	-2.3129**		
Mother's occupation	-.4287	0.7318		
Mother's age at birth	0.8114	-.1414		
Religion	0.1472	0.6555		
Caste	0.2335	0.0125		
Distance to water	0.0048	0.0128		
Irrigated land	-41.7476	-.2939		
Pre-birth medical index	0.0018	-.0718		
Distance to PHC	0.0057	-.0177		
Distance to town	0.0186	-.0236		
Distance to SC	-.1558	0.0001		
Distance to H	.0729**	0.0449		
Regions	-.4893*	0.1642		
Distance to nearest health center	0.3697	0.0335		
Level of nearest health center	-.2328	-.0227		
Number of older male siblings	0.4463	-.1486		
Number of older female siblings	0.3535			

***** p<.01; ** p<.05; * p<.10**

survival to first birthday is the omitted category or comparison group

Table 5. 10

Multinomial Logit Regression Coefficients for Male Neonatal and Post Neonatal Mortality in South India for All births 13-36 Months prior to the Survey

	Initial model		Final Model	
Number of cases	454		454	
BIC	227.4849		-8.9790	
Log Likelihood	78.42		-64.505334	
Degrees of freedom	50		10	
Variables	**Neonatal**	**Postneonatal**	**Neonatal**	**Postneonatal**
Birth order	4.1956*	2.3489*	0.9026	0.7282
Birth medical index	-1.7406***	-1.4476***	-.6654	-.8433**
Type of marriage	1.0047	-2.3294***	2.5015**	-.9928
Distance to nearest health center	.4021*	0.0889	.2285**	-.1784
Breast feeding	-6.5711**	-18.1123***	-6.1576***	18.6476***
Birth interval	-.2892	0.5039		
Gender of previous birth	-1.933	0.7113		
Housing facility index	0.005	0.0199		
Ownership of household goods	-.3215	-3.3957		
Child care	-43.8582	-2.2457		
Mother's occupation	1.9453	0.5847		
Mother's age at birth	1.4995	-1.4453		
Religion	0.3868	0.92263		
Caste	-.3617	0.0956		
Distance to water	0.0098	.0233		
non irrigated land	-1.2142	-39.3902		
Pre-birth medical index	-.0387	0.0726		
Distance to PHC	0.053	0.0014		
Mother's education	-.2701	0.9918		
Distance to town	-.0446	-.0481		
Distance to SC	-.0205	-.0078		
Distance to H	-.0368	-.0714		
Regions	-.2612	-.1034		
Level of neatesthealth center	-.1303	-.3042		
Number of older male siblings	-1.9536	-1.2371		
number	-2.6519	-.2841		

***** p<.01; ** p<.05; * p<.10**

survival to first birthday is the omitted category or comparison group

Table 5. 11

Multinomial Logit Regression Coefficients for Female Neonatal and Post Neonatal Mortality in South India for All Female Infants Born 13-36 Months prior to the Survey

	Initial model		Final Model	
Number of cases	485		485	
BIC	213.1808		-10.1251	
Log Likelihood	-28.7454		-40.7756	
Degrees of freedom	46		6	
Variables	**Neonatal**	**Postneonatal**	**Neonatal**	**Postneonatal**
Birth medical index	-1.8791***	0.0288	-.1558	-.2101
Distance to nearest town	.0729**	-.5059*	.0212	-.0867
Breast feeding	-5.5267***	-3.5621*	-5.3411***	-3.8987***
Birth order	-2.4594	5.2305		
Birth interval	0.9912	6.2216		
Gender of previous birth	2.3663	-9.2751		
Ownership of household goods	3.115	-38.8271		
Housing facility index	-.4260	3.2189		
Mother's occupation	-1.9101	6.8155		
Mother's age at birth	-.3764	11.1906		
Religion	0.778	-3.3412		
Caste	0.8928	-1.5067		
Distance to water	-.1533	-.3334		
non irrigated land	0.3788	2.2144		
Pre-birth medical index	-.1555	-1.2510		
Distance to PHC	-.1695	-.3889		
Mother's education	-.6951	2.0661		
Type of marriage	2.8229*	-4.8874		
Distance to SC	-.2071	0.2545		
Regions	-.0259	0.8835		
Distance to nearest health center	0.4791	0.1514		
Level of nearest health center	-.6982*	0.5235		
Number of older male siblings	1.0592	-.1983		
Number of older female siblings	-.7897	3.7676		

***** p<.01; ** p<.05; * p<.10**

survival to first birthday is the omitted category or comparison group

In the south on the other hand, gender of child, mother's education, and type of relation between the parents can be significantly linked with infant survival. These relationships are discussed and explained separately in the context of my hypotheses in the following sections.

For the male and female infants separately, the models differ between themselves as well as between the north and the south. Tables 5.7 and 5.8 and Tables 5.10 and 5.11 show the coefficients for the initial and final models for male and female infants in the north and the south respectively. Breast-feeding and medical care during birth significantly affect male and female infants both in the north and the south. The factors that reflect distances to health centers significantly affect only male infants both in the north and the south (Tables 5.7 and 5.10). However, gender related factors like gender of previous birth and number of surviving older male siblings are important factors in determining the odds of survival for northern males only (Table 5.7). Type of marriage between parents has a significant impact on male survival in the south (Table 5.10).

The odds of survival of northern female infants (Table 5.8), unlike their southern counterpart, are determined by factors like caste, ownership of land, number of surviving older male siblings, child care, and type of marriage between parents. These results indicate that while male and female survival in the south is affected mostly by medical factors, survival in the north largely depends on cultural, socioeconomic and demographic factors in addition to the medical factors. Also, the impact of societal factors increases during the postneonatal period when the medical factors slowly take a back seat.

Gender

It has been well known that a preference for sons over daughters is widespread in India (Williamson 1976; Cleland, Verrall, and Vaessen 1983; UN 1985; Arnold 1987) and female mortality has typically been found to be higher than male mortality especially during childhood (Ghosh 1987; Preston 1990; Pebley and Amin 1991). Based on the known biological advantage that female infants have over male infants, it can be expected that under normal conditions, gender is a significant factor determining infant survival, with an advantage for female infants over male infants. However, in a scenario of son preference where cultural and social conditions can lead to a preferential treatment of male infants, the survival chances of female infants can be lowered by inferior care to daughters in terms of food allocation, prevention of diseases and accidents and treatment of sick children (Chen, Huq, and D'Souza 1981; Kielman et al. 1983; Kynch and Sen 1983; Nadarajah 1983; Sen and Sengupta 1983; Koenig and D'Souza 1986; DasGupta 1987; Phillips et al. 1987; Basu 1989; Faveau, Koenig, and Wojtyniak 1991; Muhuri and Preston 1991; Nag 1985; Pebley and Amin 1991).

Within such a cultural milieu of son preference it can be expected that gender will be a significant factor in determining infant and young child survival but the advantage will rest with the male infants instead of the females. Hence, it can be expected that under normal conditions where there is little or no discrimination against girls, gender will be a significant variable in the regression and female infants will have a significantly higher chance of survival. However, if sons are more favored than daughters as in the north, the gender of an infant will be a part of the most parsimonious model but females will have a lower chance of survival. However, any deviation from the normal will point

toward some degree of discrimination against women, since under normal biological conditions, females will have a survival advantage over male infants. In order to study how gender of the child could be related to survival status in the north and the south, I hypothesized (H_4) that the gender of an infant is significantly related to its chances of survival with higher female than male mortality in the north and lower female than male mortality in the south.

Within the framework of this analysis, gender of index child was entered as a 0/1 dummy variable indicating male and female infants respectively. Gender appears to be a significant factor only in case of the southern model (Table 5.9). In the southern case, females have a significantly higher chance of survival than males during the postneonatal period. Based on these results, I can conclude that (H_4) stating that gender is significantly related to infant mortality can be accepted, but only in case of the southern study states. The absence of gender in the most parsimonious model for the north can be interpreted in two ways: First, the results of gender discrimination begin to appear significantly after infancy when the mitigating factors that minimize the biological advantages of female infants over male infants become robust. Previous studies have shown the significance of gender with regard to survival. However, most all of the previous studies that have been done on gender differentials in mortality in India, deal with child mortality. Second, India is progressing toward a society where the results of gender discrimination are being slowly overcome by other socioeconomic improvements. Perhaps, it more likely points to a transitional phase in the demographic history of the country, where in spite of a cultural hunger for sons, the society is moving toward a more

equitable distribution of the factors that can lead to significant differences in the survival chances of male and female infants.

Although, the absence of gender from the most parsimonious model for the north indicates a situation of moderate differential between male and female survival compared to the earlier studies on child mortality, which have identified a more unbalanced situation, it does not in any way eliminate the idea of a gender bias present in north Indian society. The very fact that gender is not included in the northern model demonstrates that the infant mortality situation in the north deviates from the norm, where gender is expected to be a significant determinant of survival, due to biological differences between male and female infants. The very fact that there are higher female deaths in northern India during infancy and more especially during the neonatal period when females have a biologically higher chance of survival bear testimony to a gender bias against females. Furthermore, it is noteworthy that even in the south, girls have a survival advantage over boys only in the postneonatal period. This suggests that son preference operates to equalize survival chances in the neonatal period. In other words, gender preference also exists in southern India but is manifest in a different form and weaker strength.

To study the effect of gender on survival status, the gender of the previous child is also included in the multivariate models. I hypothesize (H_5) that the gender of the previous birth significantly affects infant survival. Gender of previous birth is included in the multivariate equation as a three-category variable, where 0 indicates first births, 1 indicates a male previous birth and 2 indicates a female previous birth. In this analysis, gender of previous birth significantly affects the survival status of northern male infants

only (Table 5.7), and male infants who follow the birth of a girl have higher odds of surviving to their first birthday instead of dying during the postneonatal period. Based on these results, (H_5) can be accepted only in case of the male infants in the northern study states.

It is pertinent to point out in this connection that the birth of a girl is more likely to be followed after a short interval by the birth of a younger sibling, and that mortality risks during childhood have consistently been found to be positively related to short birth intervals (Hobcraft et al. 1985; Palloni and Miller 1986; Retherford et al. 1989; Govindasamy et al. 1993; Muhuri and Menken 1993). In spite of a situation where the median birth interval following the birth of a girl is usually one month shorter than the median birth interval following the birth of a son, and where very short birth intervals are more common following the birth of a daughter (International Institute of Population Sciences 1995), boys in the northern study states experience higher odds of survival if they follow the birth of an older sister. In a society where girls are usually considered to be an economic liability and boys are considered as a social, economic and religious asset, the birth of a son is always welcome. However, the birth of a son immediately after a daughter further improves the status of the infant son in the family. It can be expected that parents and other family members in north India make sure that the boy receives extra care, extra food and extra love. This special nurturing of the son can improve significantly the survival chances of an infant boy. Also, an older female sibling might also act as a surrogate mother for the baby when the mother is out working in the field or elsewhere. Although the difference in age between the two siblings may be very small, rural north Indian girls take on the role of mothers very early on in their lives; they

help in the reduction of accidental deaths especially during the postneonatal period when the infant is mobile. At least, the immediately older female sibling will not pose any competition with respect to food especially during the postneonatal period when solid foods are introduced into the diet of an infant

The Relation between Infant Mortality and the Gender Composition of the Family

In a society where son preference is culturally embedded in the family building process, it can be expected that not only the gender of the index child and the gender of the previous child, but the gender composition of other surviving children will have an impact on the survival status of the index child. Having a greater number of surviving older male siblings can improve the survival chances of infants, both male and female. The birth of a son in a family, which already has some older male children, is considered as an insurance against any possible future mortality risks. Also, after having the desired number of sons in the family, the arrival of a daughter can be welcome and her survival status improved. But it is also true that the birth of a daughter following several sons reduces her chances of survival since she can be expected to be at a disadvantage with respect to the limited resources in the household, especially food. To study the impact of the gender composition of the household on infant survival, I hypothesize (H_6) that the gender composition of the family significantly affects infant survival in the northern and southern parts of the country.

The gender composition of the family is reflected by two variables indicating the number of surviving older male siblings and the number of surviving older female siblings. Although the number of surviving older female siblings is not a part of any of the models for the north or the south, the number of surviving older male siblings plays a

significant role in determining infant survival in the northern study states, both male and female (Tables 5.7 and 5.8). For both male and female infants (Tables 5.7 and 5.8), having a number of older male siblings significantly improves the odds of survival during the neonatal period. During the postneonatal period however, male infants continue to thrive if they have a number of older male siblings, while female infants experience higher odds of death than survival to the first birth day.

The positive impact of more male siblings can be explained in 2 ways: First, since sons are valued in north Indian society, once the desired number of sons are born, the parents might be satisfied with whatever the gender of the next offspring. This will improve the survival of an infant irrespective of gender. Second, the birth of a son is more likely to be followed by a longer interval than the birth of a daughter (IIPS 1995). It has been found that mortality risks during infancy are positively related to short birth intervals (Hobcraft, McDonald, and Rutstein 1985; Govindasamy et al.1993; Muhuri and Meken 1993). Therefore the presence of sons in the household implies longer intervening birth intervals which in turn can improve the survival chances of infants, both male and female, especially during the neonatal period due to the greater importance of biological factors during this early period of life.

However, for female infants, the positive effect of having older male siblings during the neonatal period is transformed into a negative effect during the postneonatal period. For female infants in the northern study states, having more male siblings can be an impediment to postneonatal survival. The increased mortality chances of girls with older brothers can be explained in two ways: First, it is possible that in these poor rural areas, especially in Uttar Pradesh which is one of the poorest states in India, a girl will be

subject to greater competition if there are more boys in the household. This competition for limited resources, most especially food, is very severe due to the presence of several 'higher status competitors' (Arnold1998). This competition will usually start after the neonatal period when the infant is first introduced to mushy solid foods. Second, for immunological reasons, a child is more likely to get measles from an opposite-sex sibling than a same sex sibling (Aaby et al.1996). Hence a female infant is more likely to get measles from her brothers than her sisters. Incidentally, these northern states and especially Uttar Pradesh have the lowest vaccination coverage of children for measles (IIPS 1995). These results reject (H_6) for the southern study states but cannot reject it for the northern study states.

Breast Feeding, Medical Care and Infant Survival.

Breast-feeding is increasingly being recognized as one of the most important factors that lead to higher infant survival (UN 1996, WHO 1994). To assess the importance of breast-feeding, I hypothesized (H_7) that breast feeding significantly improves infant survival irrespective of region and gender. In this study, I included breast feeding into the regressions in two forms – first, as a 1/0 dummy variable indicating whether the child was breast fed or not, respectively, and second, as an index incorporating the time and manner in which the child was breast fed (as described in chapter III). For the northern study states, breast-feeding was entered into the regression as an elaborate index, while for the southern states, only a dummy variable could be used, due to the lack of cases that were not breast-fed.

Results from this study (Tables 5.7, 5.8, 5.10 and 5.11) indicate that amongst the major factors that improve the survival chances of infants, both male and female,

irrespective of region of residence, breast feeding is the single most important. Based on these results, I accept (H_7) that breast feeding significantly improves both male and female survival in the north (Tables 5.7 and 5.8). However, in the south, although breast-feeding improves both male and female survival during the neonatal period, it increases the odds of male infant death during the postneonatal period, when it lowers the odds for females (Tables 5.10 and 5.11).

The importance of breast feeding lies in the fact that it transmits to the infant, along with nutrients for growth, certain immunity-raising elements which can help fight the high infection load found in the environment, where the replacement foods are not ordinarily free from contamination. For the northern study states, the use of the breast-feeding index also helps to demonstrate the importance of early initiation of breast-feeding. Since, in a large proportion of the population, breast-feeding is not initiated for 1 — 3 days, the newborn are given some prelacteal food. Also, in some cases the first milk, which contains the antigens, is squeezed from the breast before feeding the baby. Most prelacteal feeds consist of some herbal concoctions, called "gutti" often mixed with "ghee" or honey or even castor oil. This feed is believed to cleanse the infant's system. Plain water with honey, sugar or jagary is a normal prelacteal food. Occasionally, before the flow of breast milk is established, one part of cow or buffalo milk diluted with 2 or 3 parts water is also given. Hardly any studies indicate whether water used to prepare these prelacteal feeds is boiled or not. If the water is well boiled, these prelacteal foods may not cause any ill effects. The problem, however, arises with the manner in which these feeds are given. Often, a piece of cotton or a rag is reportedly dripped in the feed and drops are squeezed into the baby's mouth (Basu 1992). Results from the northern study

states indicate that north Indian infants have better chances of survival if breast-feeding is initiated early and if the first milk is not squeezed out of the breast before feeding the baby.

In spite of the inherent qualities of breast milk, during the postneonatal period and beyond, an infant's diet needs to be supplemented with mushy solids. Most mothers in developing countries have a history of weak and fragile health, which often results in relatively low milk production during lactation. If infants and young children are only fed breast milk from the mother who can offer very little, the infants might be weakened and made anemic. Such an inadequate diet can increase susceptibility to diseases and lead to higher mortality. Perhaps this is the case with male infants in the south during the post-neonatal period (Table 5.10). This negative effect of breast feeding observed in case of southern male infants can be attributed to the fact that breast feeding was not supplemented with other foods, since breast feeding in itself is very unlikely to have any negative impact on survival. It can also be true that even if solids are introduced into the diet of an infant, 6 months or older, the diet is nutritionally deficient since a south Indian diet is solely based on rice, while north Indians usually consume more than one cereal, together with a wide range of legumes and pulses (Basu 1992).

However, it is interesting to note from the results of this study that only male infants in the southern study states are impacted by these nutritional deficiencies. Although it is beyond the scope of this research to study the duration of breast feeding and the time of introduction of mushy solids and the gender disparities therein, it would be interesting to study in future, whether these factors could differential impact male and female survival in the south. However, it can at least be pointed out that since male

infants are already physically weaker than the female infants, they succumb to these nutritional deficiencies more easily. In this connection, I consider it important to state that the NFHS presents a very mixed picture of dietary practices of infants in the country as a whole.

The National Report of the NFHS 1992-93 reveals that on the positive side, the duration of breast-feeding is relatively long. On the negative side, only half of the children less than 4 months old are exclusively breast fed and the introduction of solid and mushy food to the diet is typically much later than recommended. The timely complementary feeding rate for India as a whole is only 31 percent. Even at 1 year of age, almost a third of breast fed children do not receive solid or mushy food in addition to breast milk. This poses a serious problem for the health and development of India's children, which must be urgently addressed. Children in Rajasthan, Bihar and Uttar Pradesh are very unlikely to be given solid or mushy food at the appropriate age. Some feeding problems are universal, however. No state comes even close to achieving the recommendations for exclusive breast feeding of children under 4 months of age or the supplementation of breast milk with solid or mushy food at age 6 – 9 months. These poor feeding practices are undoubtedly a factor in the nutritional deficiencies of Indian children.

In order to assess the impact of medical care on infant survival, I hypothesized (H_8) that medical care significantly improves male and female infant survival in the northern and southern study states. I introduced two independent variables related to medical care. First, the prebirth medical index which measures various medical issues prior to birth (as described in Chapter III). Second, the birth medical index, which

incorporates the place of birth, complications during birth and the size of the baby at birth (also described in detail in Chapter III). Results from this study (Tables 5.6 – 5.11) indicate that in general, medical care during pregnancy and at the time of birth improves infant survival, both in the north and the south. However, it is noteworthy that medical care has a greater impact on male survival both in the north as well as in the south (Tables 5.7 and 5.10). This could perhaps be attributed to the fact that medical care, especially antitetanus shots and hygienic conditions during birth are important in case of all infants but more effective in reducing male infant deaths, who are more prone to infections due to their biological frailty.

In the north, male infants benefit from prenatal medical care during the neonatal as well post-neonatal period (Table 5.7). Medical care at the time of birth significantly improves male as well as female survival during the neonatal period (Tables 5.7 and 5.8)

Some of the important factors causing high neonatal mortality in northern India and particularly in the rural areas are the place of delivery, the type of attendant and the practices followed with respect to care of the newborn. In rural north India, where a majority of the births take place at home and are attended by "dais", most of whom follow unhygienic practices and aseptic methods, births at a hospital are more likely to be without complications. Moreover, in the rural areas where most births take place at home, the dais use shaving blades or domestic scissors or kitchen knives to cut the cord and apply "ghee" and cow dung ash on it in order to purify the event. Furthermore, the untrained "daises" are unable to identify complicated cases. Similarly, some research in Chandigarh has highlighted a widespread use in Haryana of giving top priority to burying the placenta, considered a pollutant, at the cost of the needs of the newborn, whose

difficulties with respect to breast feeding, etc are attended to only after the placenta has been disposed. Under such conditions, it can be expected that infant survival would be greatly enhanced by medical care, both prenatal and at the time of delivery.

In the southern study states on the other hand (Tables 5.10 and 5.11), where medical care during pregnancy and at the time of birth is more common, their impact is much lower than that in the north. In case of these states, the birth medical index significantly improves infant survival especially male survival during the postneonatal period. This is in contrast to the situation in the northern states and also to general expectations that the positive impact of medical care during birth is felt during the first few weeks of life. However, the birth medical index used in this study also incorporates the size of the baby at birth, in addition to other medical factors. In southern India, where a majority of births take place under medical supervision, the problems created by the use of unhygienic and aseptic practices are much lower than in the north. However, the size of the baby continues to affect its chances of survival and this effect can be felt during the postneonatal period of life. Under such circumstances, the birth medical index can enhance survival during the postneonatal period instead of the neonatal period.

Education

Several studies have convincingly demonstrated the important link between maternal education and infant –child survival. Based on previous research, I hypothesized (H_9) that maternal education significantly improves infant survival especially female infant survival. In the present study maternal education is entered into the regression in 2 forms – as a 4-category and a 6-category variable.

Results from this study indicate that in the northern study areas (Tables 5.7 and 5.8), maternal education is not significantly related to male or female survival. The general educational attainment of women in the north is very low. Only about 82 percent of the mothers in this study are literate and only 4 percent have completed high school. Under such circumstances it can be expected that these handful of literate mothers are unable to use or apply some of the disciplinary and hygienic measures that they have learned in the course of their education. Also, often even these mothers could be at the mercy of the older family members who are responsible for all family decisions and might determine if and when an infant is to be treated by a doctor or taken to a clinic. Furthermore, if there are no health posts within the village, as is the case for most families, the mother might be at the mercy of the male members of the family who might consider it unnecessary to take the infant to a clinic. In such a situation, father's education might have a more important impact on infant survival and it will be interesting to see in future research how paternal education will affect survival.

Similar to the northern study areas, male or female infant survival in the south remains unaffected by an increase in maternal education (Tables 5.10 and 5.11). Perhaps, in the southern states where maternal education is generally high, father's education would have a stronger and positive relationship (Gunasekharan 1988; Ramanujam 1988). In this study, I used only maternal education as a proxy for parental education based on the assumption that maternal and paternal education is correlated. However, it would be interesting to study in future how paternal education affects infant survival in India.

One interesting result from this study indicates that although maternal education does not significantly affect male or female survival in the south, in a combined male

female model (Table 5.9), maternal education does have a negative impact on infant survival during the postneonatal period. Since overall literacy levels are so high in the south Indian sample, a combination of the male and female cases perhaps gives a better distribution of mothers at various levels of education, whereas in the separate male female models, some categories might have missed cases. In general in south India, due to the generally higher level of education, there has been a general trickle down of diffusion of ideas and household practices to the uneducated as well (Basu 1992). Moreover, the south Indian cultural background which is associated with characteristics like greater maternal autonomy within and outside the household, greater female interaction with the outside world, greater and longer exposure to a modern medical care system acts in the same way as education does in a more traditional culture. Hence uneducated south Indian mothers are most likely to show similar values for several of the proximate determinants as educated mothers. On the other hand however, more educated mothers are more likely to have an occupation outside the home and this might negatively impact infant survival in the southern states especially during the postneonatal period. However, there is need for further research and use of more effective education categories in order to reach a generalization on the relation between maternal education and infant survival.

Distance to Health Care

Medical interventions in the form of preventive or curative treatment have resulted in an increase in life expectancies and in improved infant mortality rates in India as in other parts of the world. However, these medical advances can help only if they are availed by the general masses. Utilization of health services is largely controlled by the

opportunity costs incurred by the users. In developing countries like India, distance to a health center is a major opportunity cost for rural residents. Several studies have shown that the immunization rates as well as the treatment rates generally differ between the male and female children in the household. In a society where females are less valued, it can be expected that opportunity costs are higher for females.

It is expected that distance to a health center increases the opportunity costs in time, energy, and money and these affect utilization rates more for females than for males. The NFHS contains a considerable amount of information on the treatment of young children according to their gender. Mothers were asked if each of their children under age four had an immunization card or had been immunized for any of the preventable diseases. Using data from the 4 study states, I calculated the gender discrimination measures shown in Table 5.12. These are measured as ratios – the estimate for girls divided by the estimate for boys.

Girls in the north have a disadvantage over boys with respect to having immunization cards especially when the interviewer wanted to see the card. On the other hand northern females have an equitable share in the ownership of immunization cards when the interviewer did not see them. These immunization cards are like a medical record for the infants and are used to monitor a scheduled vaccination series. However, they do not necessarily mean that each infant who has a card has been timely and fully immunized. In fact, according to the NFHS, boys have a slight but consistently higher rate of immunization coverage for each of the six major vaccine-preventable childhood diseases in the country as a whole, but this disadvantage is particularly striking in the

northern states of Punjab, Uttar Pradesh and Rajasthan where full vaccination coverage for girls is less than 80 percent as high as the coverage for boys.

Using data for the four study states, I tried to assess the level of health care available to children by measuring the prevalence and treatment rates of childhood diseases. Using information provided during the survey, by mothers who were asked if each of their children under age four was sick with a cough accompanied by rapid breathing (symptoms of acute respiratory infection), fever or diarrhea in the two weeks before the survey, I found that northern girls were reported to be less likely to suffer from each of these conditions, although questions can always be raised about whether mothers recognize these problems in their daughters as readily as they do in their sons. Also, when girls do become ill, they are less likely than boys to be taken to a medical facility or medical practitioner for treatment or given anything to treat the disease especially in the north. Although girls are more likely to be treated in the private sector, they are less likely to be treated by a private doctor in the north. The other private sector possibilities for the daughter are the private drug stores, private mobile clinics or private home health workers, in which cases the costs are much reduced. Another factor that is evident in the northern study states is that girls are more likely to be taken first to a public facility and later transferred to a private doctor or clinic. This could also mean that girls are taken to a health facility at a more critical stage of the disease when it is beyond the medical capacity of the public facility. In this early stage of life, timely treatment is often a key to survival. One very disturbing factor evident from this table is the lack of cases that were given Oral Rehydration Solution during diarrhea. ORS has been considered to be extremely useful in the treatment of dehydration caused by diarrhea (WHO).

Table 5. 12

Medical Measures of Gender Discrimination in Ratios

Medical measures of Gender discrimination	North	South
Has Vaccination Card (seen by interviewer)	0.82	1.06
Has Vaccination Card (not seen by interviewer)	1.01	0.93
Diarrhea in last 2 weeks	0.84	0.62
Sought treatment for diarrhea	0.83	0.72
Anything to treat diarrhea	0.94	0.93
Treated (Public Sector)	0.80	0.45
Treated (Private Sector)	1.01	1.51
Treated (Public and Private Sector)	5.47	0.00
Traditional/Other	0.00	0.57
Treated (Private Doctor)	0.91	1.13
Oral Rehydration Solution	-	-
Cough in last 2 weeks	0.93	0.90
Fever in last 2 weeks	0.95	1.02
Anything to treat cough/fever	0.83	1.02

Table 5. 13

Main Reasons for Having No Antenatal Checkup

Northern States of Uttar Pradesh and Haryana	
Reasons	Percent of women
Lack of knowledge about services	16.6
Not necessary	39.1
Not customary	6.05
Financial cost	**3.8**
Inconvenient	**2.11**
Poor Quality service	1.27
Home visits by health worker	12.38
No time to go	**8.86**
Not permitted to go	8.0
Other	1.83
Total	100

Although immunizations are known to affect infant mortality, these variables could not be controlled in this analysis, since this information was available only for living infants. Instead, distance to health centers was used as a proxy for these variables. Distance to various health centers like Hospital (H), Primary Health Center (PHC) and Subsidiary Health Center (SC) as well as the hierarchical level of the center were entered into the regressions as separate independent variables. Distance to each of these centers was measured in Kilometers. To assess the impact of distance, I hypothesized (H_{10}) that proximity to a health center significantly improves infant survival especially female survival.

In this study, distance to the nearest health center, irrespective of its level in the medical hierarchy, significantly improved male survival during the neonatal period, both in the northern and southern study areas (Tables 5.7 and 5.10). Since the neonatal period is the most crucial period in the life of an infant and since any illness during this period warrants immediate medical attention, it can be understood why distance to a health center is so important during this period. One interesting factor about the relation between health care and infant survival is the gender differential. In case of male infants, distance to health care seems to be important during the neonatal phase while for female infants distance to health care does not matter. This might be indicative of the fact that discrimination against females is such that it is not deemed necessary to take a sick baby girl to the doctor or clinic, irrespective of distance. While on the other hand parents try to take male infants to a medical facility when they are ill and the closer the medical facility the easier it is for the parents.

Another interesting feature of the proximity-survival relationship in the northern study states is that the further the male infant lives from a subsidiary health center, the better the chances of survival during the neonatal period. The subsidiary health center is at the bottom of the medical hierarchy in the country and is most often ill equipped with regard to personnel, medications and instruments. Hence taking a sick infant, who is less than a month old to the sub center might simply mean a sheer waste of time. This could be avoided if the parent lived away from the sub center and had to take the baby to a medical center of higher order. Based on these results, I conclude that physical proximity to a health center improves male survival only, irrespective of region of residence. However, in case of the northern male, the level of the health center is also important.

In order to examine the distance factor in further detail, I explored the data to look for various causes that lead to non-usage of medical facilities, in addition to the factor of distance. One of the questions asked in the NFHS to mothers who had not availed medical care during pregnancy was the reason for their not doing so. Although distance was not listed as one of the reasons for not availing medical care, financial cost, inconvenience and time constraints were some of the few factors that could imply the distance factor. Using data from the 4 study states, I calculated that for the southern states, less than 5 percent of the mothers had not availed medical care during pregnancy while for the northern states, the figure rose to over 50 percent.

For the state of Uttar Pradesh and Haryana, the most common reason for not availing antenatal care is the thought that it is not necessary (Table 5.13). Financial cost, inconvenience and time deter the usage of medical facilities for about 14.77 percent of the women. It is evident from this that distance, cost and inconvenience do have a

negative impact on the usage of health facilities but the thought that these services are not necessary and a lack of knowledge about these services are more important in keeping these women away from getting medical help when needed. However, one might also argue that some of the other reasons for not visiting a health center, for instance, lack of knowledge of a the presence of a health center, and considering it unnecessary might also be related to distance. Indeed, people who live closer to health services tend to know more about their usefulness and necessity. Another noticeable factor here is the importance of the home health worker. More than 12 percent of the women do not visit a health center because a home health worker visits them at home. The home health worker is a significant concept that can improve the infant child situation and also create an equitable pattern of treatment of the male and female child, since this does not require any effort or expense on the part of the parents.

Blood Relationship between Parents

Marriage between relatives is a form of inbreeding that has implications for mortality, morbidity as well as fertility. Bittles et al. (1992) found a positive association between consanguinity and fertility in 19 out of 22 populations. They also found that mortality in significantly higher among children of marriages between blood relatives. In Pakistan, Bittles (1991) found that children of marriages between relatives had consistently higher mortality than children of marriages between non-relatives, in line with expectations based on genetic theory, and that couples in consanguineous marriages have higher fertility than non-consanguineous couples. Also, a tendency for marriage between relatives is more common in lower socioeconomic groups, especially in north India and also Kerala, whose mortality is higher primarily for socioeconomic reasons.

For example, in the northern state of Uttar Pradesh, less educated women and Muslim women are much more likely to have married relatives. Based on these factors it can be expected that children born to parents who are in a consanguineous marriage will have a higher mortality rate. On the other hand, it is also true that since women's' status has a definite connection with the survival of her children, especially her female children, it is expected that a blood relation between the parents of an infant which somewhat makes it easier for the woman to settle down in a new household, will help to improve the survival chances of her children.

Based on these issues, I hypothesized (H_{11}) that children born out of consanguineous marriages have a significantly higher chance of mortality both in the north and the south. The type of marriage was entered into the regressions as a 0/1 dummy variable indicating consanguineous and non-consanguineous marriages respectively. In this study, consanguineous marriages were found to enhance the chances of survival of northern females and southern males during the neonatal period of life (Tables 5.8 and 5.10). However, in north India this early enhancement in female survival is replaced by higher mortality during the postneonatal period (Table 5.8).

The fact that the positive impact of consanguineous marriages is felt only during the neonatal period and only by females in the north and males in the south is perhaps indicative of various related factors. First, a consanguineous marriage can mean better care for the mother, since she is related by blood to both the families. As the health and survival of an infant during the neonatal period is to a great extent determined by the medical and nutritional condition of the mother, an infant thrives if the mother is well cared for. However, if prenatal care is the key then it should not discriminate between

boys and girls. But if the mother is related to the husband's family, she might be cared for even after she gives birth to a daughter, which might otherwise be unusual especially in the north. This improved care received by the mother after birth and during lactation can lead to better survival prospects for the north Indian female infant, who is dependent on the mother for nutrition during these early weeks of life. Perhaps, north Indian male and south Indian female infants do not benefit significantly from consanguineous marriages simply because they and their mothers are well cared for even in non consanguineous marriages.

Also, the relation between type of marriage and infant survival could be affected by other factors as well. For instance, in the northern states of India, where consanguineous marriages are mostly limited to families belonging to lower castes, the caste and gender relation could affect female survival. More studies, in some of the other states in India would perhaps provide an improved understanding of this complicated relation.

Also the evidence from north India (Table 5.8) suggests that the advantage that female infants of related parents experience during the neonatal period is reversed during the postneonatal period. This is contrary to the belief that a blood kinship of the parents would mobilize a slew of relatives from both sides of the family tree in a commitment to the health of the infant. The negative impact of consanguineous marriages on females in north India reiterates that a kinship relation of the families does not change the feeling of gender bias embedded in Indian society, but only improves the quality of care received by the mother. Once she reaches an age where consumption of solids can lead to competition between siblings and within the family, the northern female looses her initial

advantage. Furthermore, both families in a consanguineous marriage could subject the female infant to a negative bias.

Land Ownership, Caste and Gender

In the highly populated, fertile plains of rural India, where agriculture is the most important occupation, land is considered wealth and due to the uncertainty caused by a dependence on the monsoon rains, ownership of irrigated land is the most important source of wealth. The number of acres of irrigated or non-irrigated land depending on which has a lower BIC in the bivariate analysis measures land ownership in this study. Assuming that ownership of irrigated land would mean a socioeconomic advantage to the preservation of life, I hypothesized (H_{12}) that ownership of land would significantly improve infant survival, irrespective of gender and region of residence. Results from this study (Table 5.8) indicate that the ownership of irrigated land by a family significantly affects female survival in the northern study states only. It increases the odds of postneonatal mortality versus survival to the first birthday for a female infant.

A rise in the socioeconomic status brought about by increased land ownership can mean a higher status in a traditional rural society. Such a status would require increased expenditure in the form of dowry for each marriageable daughter in the household. This could lead to an increase in the financial burden of the family with the birth of a daughter. Also, rich rural households in northern India who own large land holdings employ machine and men to work in the fields. Women in these households are not expected to be a part of the labor force thus further reducing the economic worth of daughters. These factors can lead to a situation where female children are unwelcome and neglected in richer households and suffer significantly higher risks of mortality than their male

counterparts. Also, an improvement in the socioeconomic status of household brought about by the ownership of land does not in any way ensure that the fruits of the wealth are equally distributed among the family members, as the power of the purse remains with the male members and the older women in the household. This relationship between land ownership and female survival can be further elaborated by an examination of the role of caste in northern India.

Interestingly enough, female infants of the northern study states have a significantly higher chance of survival if they belong to a scheduled caste or tribe. Castes of the upper level, of which the majority of the members are propertied, show a greater chance of female deaths during the postneonatal period. The earliest records show evidence of the practice of female infanticide in the early part of the century by the upper landed castes. This pattern of female infanticide might have been carried over into the 20^{th} century practice of female neglect, due to the pressures on property- holding families to bear sons as heirs.

Propertied castes are prompted to marry their daughters only to families with status at least equal to, preferably higher than that of their own. In the northern rural areas, the payment of a large dowry is the only way to secure a husband of such a high status family. As a result of the financial burden of marrying off a daughter on one hand and the unbearable shame and danger of having a nubile daughter still at home on the other, families choose to neglect their daughters. On the other hand, daughters in lower caste households add to the number of workers or wage earners in the family. They can work in their own field, or be hired by richer households as domestic or field workers. Also, the need for a large dowry is much lower in these households. Hence women and

female infants are less of a burden in these households. In contrary to my hypothesis (H_{12}), in northern India female infant mortality is significantly higher in households with a higher level of land ownership.

Child Care

Availability of childcare in addition to the mother is found to be a significant factor in improving female postneonatal survival in the north. Mothers were asked if there was some one to care for her infant if she sometimes or never took the baby to work. Most of this additional care came from husbands, older children and other relatives. The importance of additional child care is that these care givers usually live in the same house and care for the infants not only when the mother is not around but also at other times during the day.. This is particularly true for female infants during the postneonatal period. Since female births in India are followed by a shorter birth interval (IIPS 1995) and an extra caregiver in the household could mean better care for the infant when the mother has already conceived another baby. Also, an extra care giver could reduce some of the child care load of the mother when she is already under a lot of pressure due to the birth of a daughter in the family and in turn improve the quality of the time she spends with her daughter. The presence of an older sibling, especially female also improves the survival chances of infants in the north. In families where the fathers and grandparents or other relatives are present in the household, the workload is often divided between the family members and the infant receives more attention perhaps from all of the family members at different times. It also reduces the mental and physical fatigue of the mother following childbirth. In rural India, where institutional childcare is at a very low level, help from the family members can at be an alternate source of help.

It should be pointed out however, that the presence of family members from an older generation could often lead to generational conflicts in the manner in which the infant is brought up. This can also result in negative consequences if, for instance, the usage of medical care is deemed unnecessary by the grandparents at a time when only medical attention can save an infant's life. However, it is important to note that the fact that an additional source of childcare saves the girls life in the postneonatal period only shows that social factors become more important in the postneonatal period.

Conclusions

In this analysis, I have provided empirical basis for the explanation of gender differentials in infant mortality. Results from this study reveal that gender disparities in infant survival are evident in India. Both in the northern and the southern study states, female infants do not experience the survival advantages bestowed to them by nature. However, the gender disparity in the mortality pattern differs in degree between the north and the south. The situation with regard to a female disadvantage in survival is more pronounced in the north. In southern India gender plays a major role in determining the survival status of infants and female infants have a significantly higher chance of survival, but only during the postneonatal period. In northern India, gender is not a factor in determining the survival status of infants in spite of their biological advantages. Since female infants are expected to have better chances of surviving during infancy due to biological reasons, this absence of gender from the northern model indicates the presence of some bias against female children which results in the removal of the biological advantage that female infants have over male infants. However, it also indicates that the dire results of gender discrimination that result in higher female mortality that have been

found in most other studies of child mortality (1-5 years) in north India is not as pronounced during infancy. This can be due to the fact that the effects of son preference which results in discrimination against daughters intensifies after infancy, when the child depends mostly on solid foods for survival. It can also be true that although son preference continues to persist in northern India, these states are slowly moving in the direction of the southern states, which are characterized by a relatively weaker preference for sons. In this connection, Leela Visaria states that there is some evidence of a general decline in son preference and writes that 'There is evidence of inter-generational tensions and conflicts such that the some elderly are beginning to feel that daughters rather than sons are more dependable for emotional and even financial support' (Visaria 1994). If this continues to be true and the improved economic worth of daughters change the cultural advantage of boys, the survival chances of female infants may be further improved.

However, son preference is likely to persist in India for some time and there are no simple answers in the study of gender discrimination. Clearly, independent forces interact to produce and reinforce the preference for sons in India and excess female mortality in the north has both economic and cultural roots. For example, this study reinforces some previous research (Miller 1981,1993; Krishnaji 1987; Dasgupta 1993), that discrimination against females is less intense among poorer households or those with less land. It is further true that female survival is higher amongst scheduled castes and tribes. In a nutshell, there is evidence that gender bias in infant survival is lower among poorer households. Distance to a health center was found to impact the survival of male infants only. Since female infants are not considered worthy enough to be taken to a

health center at the time of an illness, the factor of distance does not affect usage. This study also identifies the effectiveness of proper breast feeding and medical care throughout pregnancy and at the time of birth in improving the general survival status of infants, both male and female. One controversial finding is the relation between mother's education and infant survival in general. While most studies have indicated a positive relation between mother's education and infant survival, this study fails to identify such a relationship. More studies are needed before a simple relation between the two can be established. There is need for more research to determine whether there is a threshold at which point the positive impact of education become visible, and the debate must continue.

VI. SUMMARY AND POLICY IMPLICATIONS

Infant mortality is one of the basic indicators of the level of development in a region. Most social scientists around the world now view the infant mortality rate as an excellent summary indicator of the socioeconomic development of a country. In India, infant mortality rates were extremely high during the turn of the century. Infant mortality started to decline significantly with a decline in general mortality after India attained independence from the British in 1947. Since then, India has been making rapid strides in development and the infant mortality rate has declined substantially.

An important step in the attempt to reduce infant mortality in the country was taken when the country adopted the National Family Health policy in 1981. After becoming a signatory to the Alma Ata Declaration in 1978, thereby committing the country to the goal of "Health for All" by the year 2000, the government started to concentrate on the improvement of the general health of the people. One of the major areas of focus was maternal and child health care and the government initiated the development of the rural health infrastructure in order to make health care available to the masses. The long term national demographic goal is to reduce the infant mortality rate to below 60 per 1000 live births.

In spite of the major achievements in the country, India still maintains a high infant mortality rate that stands at 79 deaths per 1000 live births. One in every thirteen children still dies within the first year of life, and one in every nine children dies before reaching their fifth birthday. In addition to this high rate of infant mortality, India also experiences two other major problems with respect to infant mortality. First, there are

wide variations in infant mortality between as well as within states. Second, there is a gender disparity in the rate of infant mortality. Contrary to the expected biological norm of higher female survival than male survival, infant mortality in India is characterized by increasingly higher female mortality after the first month of life.

Although the generally high infant mortality levels and the gender disparities therein have been a focus of research for academicians and international organizations alike, few rigorous empirical tests have been done to study these issues from a spatial perspective. Most of the previous research, usually originating in the disciplines of demography, sociology or public health has overlooked the contribution of "space". The absence of a spatial context has been common in a majority of the studies that have tried to examine infant mortality as a demographic outcome, not only in India, but also in most of the other developing world. One of the important reasons for this lack of "geography" in the study of infant mortality is the sheer lack of interest shown by geographers, even population geographers, in the subject of mortality and fertility (Sporton 1999). Among population geographers, migration and mobility continues to be the subject that is most researched and written about. The other and perhaps, equally important factor behind this lack of "space" has been a genuine absence of authentic data on mortality, especially from developing countries.

Most of the available research on infant mortality in India is aspatial, the main objective being the search for causal connections between mortality and various socioeconomic, demographic and health factors. These studies have mostly been done at the macro or state level or at the level of small villages or urban slums. Furthermore, these studies have usually focussed on the age group between 0 – 4 years or 1 – 4 years,

whereby infant mortality is studied only as a part of child mortality instead of a separate demographic outcome.

In doing this research, it has been my intention to fill in the gaps left by previous research. The availability of reliable data from the NFHS conducted in India in 1992-93 has facilitated my attempt to study the disparities in infant mortality in India in a spatial context. The general objective of this study has been to provide a better understanding of the spatial pattern of infant survival and its determinants, the relation between gender and infant mortality in India and the various factors that lead to a spatial differential between male and female infant mortality. Based on district level analysis, I have examined the spatial disparities in infant mortality and identified the regional pattern of female disadvantage in infant survival. Further, this study examined and explained the contribution of several independent variables on infant mortality as a whole and also separately for male and female infants in creating spatial disparities. Although excess female mortality is widely recognized as rooted in economic and cultural factors, few attempts have been made to evaluate the simultaneous contribution of these factors as well as other socioeconomic and geographical factors. Special attention is paid, in this study, to the relation between gender and infant mortality, in order to determine whether the discrimination against females observed during childhood also holds true during infancy. Also, this study adds several new dimensions to the study of infant mortality by introducing new variables to the equation. For instance, the impact of the availability of child care in addition to the mother, the impact of consanguineous marriages and the condition of the housing facility are some of the variables that are new in the study of infant and child mortality.

In a nutshell, I have tried to fill the lacuna in the study of mortality, by analyzing infant mortality separate from child mortality in present day India, where excess female mortality in several regions is so great that females are seen as being "endangered" (Miller 1981) and millions are missing (Sen 1990). Furthermore, I have divided infant mortality into neonatal and postneonatal mortality in order to identify the different factors that affect survival during the two stages of infancy. The underlying notion has been that a better understanding of the spatial and gender disparities in infant mortality and an analysis of the determinants of infant mortality will provide support to the academic interest in this subject and also provide useful means to identify alternative policy interventions to reduce infant mortality in general and the disparities in space as well as gender. Therefore, this study addressed the following objectives:

1. A description of the spatial distribution of infant mortality in India, in order to identify patterns of high, low and medium mortality.

2. An analysis of the interstate and intrastate disparities in infant mortality in general, neonatal and postneonatal mortality in particular.

3. An examination and explanation of the spatial patterns of female disadvantage in infant survival.

4. A study of the impact of availability of health care, gender, mother's education, occupation, land ownership, caste, religion, medical factors during pregnancy and birth and breast feeding, in addition to several other socioeconomic and demographic factors on regional differences in infant survival.

5. A study of the same factors on male and female infant survival separately in order to gauge the differential impact of these factors on the male and female infants.

This chapter summarizes the research findings, presents potential policy implications of these findings, and identifies the need for further research.

Summary of Findings

The level of infant mortality is generally high in India, with wide variations at different levels of analysis. There are wide disparities in the infant mortality rate not only between states but also between districts within states. Most of the states in southern India have infant mortality rates not only lower than the northern states but also lower than the national average. Within the states, variation in infant mortality is highest in those states that have the lowest infant mortality rates. The southern state of Kerala, which has one of the lowest infant mortality rates in the country also, has the highest disparity in infant mortality between its districts.

Gender differences in infant mortality are evident both at the neonatal as well as postneonatal phases of life. Roughly, India can be divided into two broad regions along the Narmada River, with the northern half exhibiting a pronounced disadvantage in female survival. Female infants in most of the states north and north west of this divide experience higher mortality compared to male infants, either during the neonatal or postneonatal period or during both of these periods. This female disadvantage in survival is in contrast to the biological norm of higher female than male survival, especially during the earliest period of life. The disparity between the observed and the expected pattern of infant mortality suggests that the northern part of the country "denies to many women the benefits of the normal biological superiority of their sex...." Apart from these north south differences which are believed to be rooted largely in sociocultural differences between the two regions, what is most interesting as a finding in this study is

the fact that (1) there are wide variations within the north and the south and also (2) that interesting geographic patterns other than the north south divide are also evident. For instance, in spite of being in the north, the Himalayan districts exhibit lower female mortality during infancy, while female mortality is higher than male mortality in some pockets in the south. Similarly, there are differences between the coastal and interior districts and also between the coastal areas in the west and east. Also, some of the northeastern states can be grouped together with the southern states with respect to the infant mortality experience. These spatial variations, which were generally unidentified by previous research, creates a new picture of female disadvantage in the country and points to the presence of micro spatial disparities within the two major spatial regions of the country.

A closer look at the gender mortality relation in rural areas indicates that in spite of the generally high female disadvantage in the northern states, the southern states also show some gender bias. Using four states, two each from the north and the south, I found that in the north, females are stripped off their biological advantages during infancy. In the south, female infants experience higher odds of survival, but only during the postneonatal phase of life. Higher female mortality during childhood has been a common finding in most previous studies, but what is unique in this study is the finding that a certain level of gender disparity in infant survival favoring male infants also exists in the south. Southern females have a survival advantage over male infants, but only during the postneonatal period, suggesting that southern females do not experience the full advantage of their biological superiority. In other words, gender preference exists in southern India but is manifest in a different form. In a nutshell, a gender disparity in

infant mortality exists all throughout the country, but with varying degrees of strength. Female infants is the northern states are much worse off than their southern counterpart.

The other important result of this study, which distinguishes it from other studies is the fact that female bias in the north is much lower than that observed in other studies. There can be two explanations for this difference. First, most previous research that have found very high levels of gender bias in the north, have generally focussed on the age group between 0-5 years or 1-5 years, thereby lumping the first 5 years of life together, and ignoring the independent experiences during the first year of life. It can be expected that during the first year of life, when the infant is largely dependent on breast milk, there is very little competition for limited food resources, which usually starts later in infancy and continues through the childhood years. With the introduction of and increase in the consumption of solid foods, the girl child is most likely to be discriminated against with respect to food, especially if there are older male siblings who have the socio-cultural advantage of being "higher-level" competitors. For these reasons, in the northern study states, the gender composition of the family is an important factor in determining infant survival. There is evidence that northern female infants suffer increased chances of mortality during the postneonatal period when they are preceded by several surviving older male siblings.

Second, India is moving through a transitional phase in its demographic history and the northern states are slowly following the southern states in reducing the gender gap in infant survival. However, gender disparities in infant survival, negatively affecting female infants still exist, and with greater severity in the north than in the south. The persistence of a gender bias in the north Indian states becomes more obvious with an

examination of the caste-gender –land ownership relationship. It is evident from this research that in the northern study states, female infant survival is significantly lower in households that own large acreage of irrigated land. Similarly, female survival is much lower in households belonging to higher castes.

In rural north India, where agriculture is the main occupation of the people, ownership of irrigated land is the most common form of wealth. Surprisingly, female mortality during infancy is significantly higher in these wealthier families, although one would expect that with increased wealth, there would be a reduction in the competition for food and other resources needed for infant survival. The situation in northern India points toward the existence of some external factors that mitigate the advantages of wealth. In northern India there is a difference between the economic and cultural worth of male and female children. Men provide economic support to their aging parents, continue the lineage and also perform the last religious rites after the death of their parents. Having a son is considered a "blessing" since it is a form of social security for the parents in their old age. On the other hand, a daughter is not expected to provide any support to the family once she is married. The only cultural purpose of having a daughter is to fulfill the religious rite of "kanyadaan" or giving the daughter away in marriage. In north Indian society, "kanyadaan" is one of the most important forms of philanthropy and an important way to please the gods and invoke their blessings. It is the sole duty of the parents to give their daughters away in marriage, but finding a suitable match for the daughter largely depends on how much the parents can spend in the form of "dowry". The dowry system whereby the family of the girl provides money and commodities to the groom's family as part of the wedding ceremony is most strictly followed by the higher

castes. Interestingly, families belonging to the higher castes are also the most propertied. These propertied castes are prompted to marry their daughters into households with status at least equal to, preferably higher than that of their own. This causes a substantial drain on the wealth of the family. Also, women in these richer households are not expected to work in the fields or at home, unlike the women in lower caste households, who work as domestic servants or hired field help. It is a combination of these factors that creates a milieu of extreme son preference in northern India, especially amongst the propertied higher castes. Since daughters are a financial burden, it is obviously much more advantageous to have sons than daughters in the family.

Son preference can result in various forms of neglect and discriminatory behavior toward the female infant and evidence from this study suggests that there are distinct gender disparities in the use of medical technology. Male infants in northern India have a higher rate of vaccination coverage than female infants. They are more likely to be treated for childhood illnesses and are also more likely to be treated at an earlier stage of the illness and at medical facilities of higher order than female infants. Since male infants are much more likely than female infants to be treated at a health center for illness episodes, distance to the nearest center is an important factor in determining survival, especially during the neonatal period. During the neonatal period, when timely treatment of an illness is often the key to survival, male infants, both in the northern and southern study states have higher chances of survival with increased proximity to a health center. However, due to the generally poor condition of the lowest order health center (sub centers) in the north, proximity to these centers do not improve survival.

The gender bias is so deep-rooted that it persists even when children are born in consanguineous marriages. Although a blood relation between the parents of an infant improves the care received by the mother, it cannot eliminate the gender bias against female infants. Once solid foods are introduced into the diet during the postneonatal period, female infants in the north succumb to the competition for food resources.

Among the factors that improve both male and female infant survival and thereby help to reduce the gender gap, breast-feeding and medical care are the most important. Results from this study indicate that breast-feeding can immensely improve infant survival, irrespective of gender and region of residence. One very important finding is the significance of early initiation of breast-feeding. Chances of survival are greatly increased when an infant is breast fed within an hour of birth and if the first milk is not squeezed out of the breast before feeding the baby. In addition to providing germ free nutrition, breast milk provides antigens from the mothers body that help to resist infections. Apart from breast feeding, timely initiation of solids into the diet is very important since a diet containing only breast milk could lead to anemia. Prolonged breast feeding without appropriate and timely introduction of complimentary feeding can be the main cause of protein energy malnutrition among infants. Infants need to be introduced to solid foods in the fourth or fifth month, because the quantity of breast milk does not meet the infant's growing calorie and protein needs since breast milk does not contain iron, contains relatively little vitamin D and insufficient vitamin C. As a result, infants in the age group of six months to one year, who are only breast fed can become not only weak but also less resistant to infectious diseases. In this connection, it is important to keep in mind that the NFHS suggests that although breast feeding is generally universal

in India and that male and female infants are very rarely discriminated with regard to breast feeding, the general duration of breast feeding is much lower than that suggested by medical practitioners. Also, much needs to be done with regard to the introduction of solids into the diet and consumption of a balanced and nutritious diet after the first few months of life.

Like breast feeding, medical care can significantly improve infant survival, irrespective of gender and place of residence. However, the positive impact of medical care is more obvious in the northern states, perhaps due to the generally unhygienic and aseptic conditions under which a baby is born in these states. Medical care throughout pregnancy and at the time of birth also helps in reducing the gap between male and female infant survival since it is usually done without a prior knowledge of the gender of the infant. Timely visits to a medical practitioner, use of antitetanus shots and folic acid tablets can improve survival as can the birth of an infant in a medical facility. Women in the northern states are much less likely to avail medical help during pregnancy and at the time of birth. This main reasons for this low usage rate in the north lies in the lack of knowledge of the usefulness and location of these facilities. Perhaps, these factors are a proxy for the general lack of education as well as the absence of medical facilities in most of the rural areas in the north.

Surprisingly, an increase in mother's education fails to improve survival and reduce the gender gap. Most studies in Africa, Latin America and Asia have demonstrated the importance of mother's education on infant survival. However, such positive results are not visible in this study. In the northern states, the general level of education is extremely low and a very meager minority of the mothers go beyond the primary school

level. At such low levels of education, it is unlikely that the mothers would have a knowledge of the healthy practices that could improve infant survival and also reduce the gap between male and female survival. Also, such a minority of educated women are unable to successfully cross the social barriers imposed on their movement. For instance, even if a mother is educated and realizes that her child needs medical attention, she might not be allowed to take her child to a doctor, especially if he is a male doctor. On the other hand, southern mothers are generally educated and the fruits of education have trickled down even to the uneducated mothers, thereby reducing the gap between the child care practices followed by these two groups. But in the absence of alternate childcare, infants in the south suffer when the mothers are educated enough to be employed outside the home.

It can be summarized based on the results of this research that the northern and southern regions of the country differ in the level of female disadvantage. The bias against females is rooted in economic and cultural factors. The southern states are characterized by better female survival due to various factors. Historically, the southern states have been more liberal toward women than the northern states. Women in southern India are much less of a social and economic burden on the family than those in the northern states. These historical characteristics have been complemented by improvements in health care and education. Unlike northern villages, most southern villages have a health facility within the village itself. This has led to a gap in the utilization of medical facilities between the north and the south. Also, a difference in the level of education in the two regions has led to differences in the attitude toward the need for medical care. With higher education levels in the south, the positive effects of

education has trickled down to increase survival even amongst the uneducated, although odds of mortality can be higher for infants of educated absentee mothers. Thus, it is a combination of cultural, socioeconomic and health care practices that have created the differences in the mortality pattern between the north and the south.

Policy Implications

It is evident from this research that various socio-cultural factors have led to variations in infant mortality both in space and between the two genders. A general improvement in the economic worth of women can improve infant survival. For instance, it is clear that in lower caste and poorer households in northern India, where women work in the fields and in the home, the survival gap between the male and female infant is much reduced. There is also an immense need for a change in the age-old cultural practices, which are mostly discriminatory toward women. The system of dowry and other related marriage and property laws need immediate amendment in order to spell out a new and more favorable role for women in society. In a nutshell, the economic and cultural postulates that have helped to reduce the position of women in society need to be modified. Having emphasized the need for such sociocultural changes, I have to admit that such changes can be accomplished only through time. In a country like India, where history is a part of everyday life and where traditions are the foundations of modern practices, it is perhaps ill conceived to expect such revolutionary changes in a short period of time. However, findings from this research suggest that certain policy interventions could be useful in order to reduce infant mortality in general as well as gender differentials in infant mortality.

(1) Breast-feeding is one of the most important factors that significantly improve the infant morality situation in India, irrespective of gender. Although, breast-feeding is almost universal in India, women should be educated about the importance of proper timing of the initiation of breast-feeding. They should be explained how the first milk, which is in several cases squeezed out before feeding the infant, contains important antigens which if fed to the infant can increase his/her resistance to several illnesses. At the same time, the importance of mushy solid foods should be explained so that the infants are introduced to solid food at a recommended time during the postneonatal period. The importance of proper breast-feeding lies not only in its usefulness but also in its economic effectiveness, especially in a poor country like India.

(2) This study has shown the importance of prenatal care and care at the time of delivery for lowering mortality during the first year of life. The importance of these factors is further enhanced by the fact that they help the infant irrespective of gender. To persuade pregnant women to immunize themselves against tetanus and thereby minimize the risk against neonatal tetanus among their offspring, health services need to be more easily available and accessible.

(3) Availability of medical care at a comfortable distance can save the lives of infants. Although results from this study suggest that only male mortality is positively affected by the physical proximity of health facilities, it can be expected that with more health centers close to home, female infants will also be taken to these centers for treatment due to the greatly lowered opportunity costs. It can be expected that parents ordinarily do not resist the immunization of their children against diseases like diphtheria, polio, tetanus and measles, if the services are made available at a reasonable distance and

the utility of these services are explained to them. In India where parents usually take only their infant sons to health centers and where subsidiary health centers are so ill equipped that they can reduce survival chances, the home health worker can be of great use in reducing the gender differentials in utilization rates of health centers. In this connection, the importance of the home health worker should not be underestimated. Also, mothers should be educated about the effectiveness of home remedies that could save lives and cost less. For instance, importance of the use of Oral Rehydration Therapy (ORT) for cases of diarrhea should be emphasized to mothers. Surprisingly, I found that this effective and cheap method of treating dehydration during an episode of diarrhea was almost unused by mothers in all 4 study states.

(4) With an increase in the number of mothers who are working outside the home especially in the southern states, there is an immediate need for alternative care for infants. Availability of professional care will ensure that children are cared for while the mother is at work and will also help to eradicate the negative impact of education which operates through the work status of the mother.

Conclusions and Need for Further Research

Several important conclusions emerge from this analysis. On the first point, I confirm a strong north south dichotomy separating the high morality northern region from the low mortality southern region in India. Disparities in infant mortality are evident at the regional, state and district level. The northern states, especially the north western states experience much higher infant mortality than the southern states and the rate of infant mortality in the northern states is higher than the national average. With

regard to further regional variation in gender differentials in survival, there seems to be greater complexity to the north-south dichotomy than suggested by existing literature.

In addition to the broad north south regional divide separating the area of high female mortality in the north from the south previously recognized by most previous researchers (Sopher 1980; Dyson and Moore 1983; Miller 1980), this study identifies some spatial disparities within the northern and the southern regions, and some variations between the coastal and interior parts of the country. A somewhat similar trend was found by Malhotra, Vanneman and Kishor (1995) in their on fertility dimensions of patriarchy, and development in India, one of the two studies that analyzed gender differentials in India at the district level. However, both of these studies looked at gender differentials in infant mortality as a part of a much larger study of other demographic issues and did not focus specifically on the issue of gender differentials as an index of economic development. The strength of this study is in the use of district level information on infant mortality for the states in India and the use of statistical methods to determine the degree of disparity at various levels of spatial aggregation.

Although this research confirms the more localized spatial disparities in gender differentials beyond the broad north south divide, there is need for more studies to confirm these patterns. Furthermore, the recognition of these additional patterns of gender disparities in the spatial distribution of infant mortality in India raises the question of a secular change in these gender differentials. It will be interesting to study whether these pockets of localized disparities have experienced any changes or reversals through time.

Unfortunately, data on the infant mortality rate at the district level is very limited, but initial comparisons can be made with data from the National Sample Survey (NSS) of previous years and the NFHS of 1992-93. It is also important to study whether these patterns can be related to similar spatial peculiarities in the distribution of other geographical, socioeconomic and demographic variables in order to find causal connections. Most importantly, it must be realized that these studies will be possible only with the availability of reliable data. For this purpose, there is need for a continuous process of evaluation by organizing a "stock-taking" of the processes, patterns and determinants of the change in infant and child mortality.

The study confirms the multi-dimensional nature of gender inequality. It unequivocally demonstrates that gender is an important factor in creating a north south differential in infant mortality. The northern states are characterized by higher female infant mortality while the southern states are characterized by lower female infant mortality. Most previous studies have shown that in Northern India, female children are at a disadvantage with regard to survival during the early years of life (Sopher 1980; Dyson and Moore 1983; Miller 1980). In her comparative study between people from Tamil Nadu and Uttar Pradesh, Basu (1992) found that during the neonatal period, girls had a relative advantage over boys in both populations. However, during the postneonatal phase, the two regional groups diverge greatly. In both cases girls lose their earlier advantage but for Tamil Nadu they now do the same as or only slightly worse than the boys, while for Uttar Pradesh male survival rates leave female children far behind. In another study done in Madurai district of Tamil Nadu, Gunasekaran (1988) also found that girls experienced a lower neonatal mortality but slightly higher postneonatal

mortality than boys, but the differences were not statistically significant. Ramanujan (1988) found that female babies in rural Tamil Nadu do not suffer from any marked disadvantage with respect to mortality during infancy. In a study done in the state of Gujarat, Gandotra & Das (1988) found that male babies had a significantly higher risk of dying than female babies during the neonatal period, whereas female babies faced a significantly higher risk of dying than male babies during the postneonatal period. Arnold (1998) found evidence of excess mortality for girls between the ages of 1 and 4 years. Girls in these states experience higher child mortality and in general and the excess mortality is more severe in families with more children.

In this research, I found that the more sharp disparity between male and female mortality as suggested by previous research does not really become significant till ages beyond the first year. However, the seeds of female disadvantage are there and these remain and gain strength throughout the first year of life such that it can manifest itself after the first year of birth. On the other hand, the results from the southern states show that although females have a higher chance of survival, this relation is significant only during the postneonatal period, thus indicating that some discrimination is also present in the southern states. It seems somewhat true that son preference is deeply embedded in Indian culture and society but its intensity varies substantially from one part of the country to another. However, more comparative studies done with data from other states in the north and the south can improve our understanding of the gender disparity between the north and the south.

This research also suggest that the impact of gender in child survival is multi-faceted – the gender of the previous child and the gender composition of the family also

affects gender differentials in survival. Male infant survival in the north is enhanced if an older female sibling immediately precedes the male infant. Also, male infants have a higher chance of survival during the neonatal as well as postneonatal period in families with a number of boys. Although girls have a higher chance of survival during the neonatal period in a family with a number of boys, during the postneonatal period, excess female mortality tends to increase with the number of boys in the family. This finding is inconsistent with earlier findings that discriminatory practices are concentrated in families with several girls (Das Gupta 1987; Muhuri & Preston 1991). However an earlier study by Simmons et al. (1982) and later by Arnold (1998) found that in the northern state of Uttar Pradesh, girls with older brothers had a greater risk of dying. Since Uttar Pradesh is of the northern states in this research, the results are consistent with the findings of Simmons and Arnold. But the question remains as to how this kind of relation between gender composition of the family and female disadvantage in mortality change with a decline in fertility that is slowly taking place in Northern India. It will also be interesting to study why female neonates have a lower risk of death in a family with more boys. Perhaps an optimum range of family composition could be identified within which the survival of a female infant could be protected.

There are no simple answers in the study of gender discrimination. It is clear that independent forces interact to produce and reinforce the preference for sons in India, especially in the north. Further research is necessary to study the impact of independent factors used in this study at different periods of time in order to understand whether there has been any significant and positive changes in the impact of caste and poverty on infant survival in the north. This research has shown that females are at a greater disadvantage

in families that own more land or are wealthier and also that female survival is higher in families belonging to the scheduled castes and tribes compared to the general population. This result is consistent with earlier findings by Miller (1981, 1983), Krishnaji (1987), and Dasgupta (1993) among others. Some authors have distanced themselves from this hypothesis (Agarwal 1986), or have suggested that poverty may not be a major determinant of gender bias in child survival (Chen, Huq, and D'Souza 1981; Harris 1990; Das Gupta 1987). There is need for more detailed empirical investigation of this issue. Furthermore, there is need to study the effect of gender differentials in infant mortality especially the survival of females with the "sanskritization" of the northern rural population. Also, more evidence is needed from the urban areas where land is not the only index of wealth in order to reflect how other forms of wealth which are not linked to lineage contribute to creating gender differentials in infant mortality.

More in depth analysis is also needed to study the relation between women's education, the distribution of food and infant survival in the northern and southern regions of the country. This research unequivocally suggests that excess female mortality in India has both economic, and cultural roots. It is clear that son preference continues in northern India. It remains to be seen if and how quickly the northern states will move in the direction of the southern states, which show relatively low preference for sons. To bring about cultural changes in a diverse country like India is largely beyond the capacity any organization. However, economic changes can be brought that could improve the general economic worth of women and in the end gradually lead to an improvement in the life chances of female infants. This attempt to gradually make positive changes can be supplemented with more revolutionary medical initiatives. Simple medical measures

like regular immunization of the mother prior to birth and the administration of iron and folic acid tablets throughout pregnancy or the use of Oral Rehydration (salt sugar solution) to prevent dehydration during an episode of diarrhea can not only reduce the infant mortality rate in general but also narrow the gender gap.

One comment appears to be in order. This study has suggested that education of the mother does not improve the probability of infant survival. Most previous research have indicated the positive impact of maternal education on infant survival although most of these studies have yielded a wide range of results reflecting the relation between maternal education and gender differentials in infant mortality. This study has suggested that education of the mother does not significantly affect the probability of infant survival in the north and negatively affects survival in the south. One way to explain the relative insignificance of maternal education in the north may lie in the fact that the positive effects of women's education trickle down through the rise in the usage of medical care. For instance, in a study done in the state of Gujarat, Gandotra and Das (1988) found that mother's education beyond the 8th grade is associated with significantly lower risk of neonatal mortality. However, mother's education has no significant effect on postneonatal mortality after controlling for the effect of postnatal care and other variables. In the northern states of Uttar Pradesh and Haryana where a large percentage of the rural areas do not have any health facilities, it could be true that the positive impact of education cannot be felt. In order to assess the synergy between education and health care in creating spatial and gender differentials in infant mortality, more comparative research is needed between the rural and the urban areas. Another point that needs to be stressed here is that while the slight education, which is all that most of the literate North

Indians can boost of in this study, can improve their ability to write or read a few words, this education hardly provides any understanding of the health and nutritional needs of a pregnant or lactating woman or an infant. Thus, it is necessary to determine at what level of education, significant improvements can be observed in the level of infant survival. One limitation of this study is that education as a variable was not coded as a dummy variable. I used 3 variables reflecting the education of the mother. Two of these variables were ordered categorical variables with four and six categories, while the third indicated the number of school years. However, the use of dummy variables can lead to an identification of the level at which the positive effect of education can be established.

In case of Southern India, the negative impact of mother's education on infant mortality during the postneonatal period is perhaps related to mother's occupation. This is consistent with earlier findings that children of mothers employed outside the home suffer higher odds of death than mothers who stay at home (Basu 1988; Kishor 1998). These studies also found that the negative impact of mother's employment outside the home was strongest in the southern states while the northern states of Uttar Pradesh and Punjab suffer the least. This difference is attributed to the fact that a large proportion of rural working women in the south work as laborers, while in the north they are more likely to be cultivators; the latter presumably being more compatible to child minding. A major explanation for the higher child mortality experience of working women can be found in their physical inability to look after their children themselves or to arrange adequate substitute childcare. Previous studies have suggested that it is the mother who first notices a child's ill health and the need to do something about it, and therefore if the mother is away, care during ill- health may be lacking (Caldwell 1986). Chowdhury

(1982) found that in Bangladesh, the time spent by the mother on child care had a positive and significant effect on the calorie and protein intake and on the dietary adequacy status of pre-school children. Hinderbrand et al. (1985) have documented the significantly higher risks of death faced by children among the Tamasheq (or nobles) in rural Mali compared to the children of Bella (or slaves). The latter can hardly claim to have greater economic resources; the main difference between the groups seems to be that Bella children are rarely physically separated from their mothers, whereas Tamasheq children are cared for by Bella nursemaids, being taken to the mothers only for breast-feeding.

To comprehend the impact of maternal education, more research is necessary to determine how education works differently in case of employed or unemployed mothers. Also before making strong conclusions about the relation between education and infant mortality in the south, it is necessary to look more carefully into the categorization of the education variable within a larger data set. Finally, one comment needs to be in place. Most earlier researchers have agreed that the positive impact of mother's education to be felt on the survival and well being of her child, she has to have some autonomy in decision making regarding her children. Although studies have shown that women's education and occupation are two of the most important tools by which the status of women can be improved and she can have more autonomy in the family, the strength of culture is often too strong to overcome with a few years of schooling. For example, the strong tradition of "purdah" in northern India refers to the full or partial veiling of married women in the presence of males, within and outside the home among Hindus and only in the presence of strangers among Muslims. These seclusion norms are much

stronger in the northern states than the southern states and has controls on mobility, effectively cutting women off from their spheres of knowledge, interaction and activity and often deters them from visiting a doctor, who is usually male when needed. Also, a women in rural India may have a few years of schooling and an occupation in the agricultural fields, but in most instances she is not working for cash. Also, earning cash does not in any way mean that she has the power to decide as to how to spend the money.

In most instances, it can be expected that the woman give all her earnings to her husband who decides how to spend the money. Also, it is in line with all anthropological studies of the household in India, especially in northern India, to expect that a young wife is to be of no consequence until she has demonstrated her worth and loyalty to the household by bearing the necessary sons and also by integrating completely into her husband's kinship group. Household autonomy is at the lowest level for these young women and most of the control lies in the hands of the older females in the household. This study is limited in controlling only for mother's education. It will be interesting to see how education of the older females in the household is differentially related to infant mortality in the north and the south.

Finally, the fact that more children die more often in the south if a mother is educated does not in any way imply that a mother's education should be discouraged. Instead it suggests that society and culture have not adapted so as to ensure that the alternatives of childcare are available to women who are educated and work . This excess mortality reflects the fact that when the mother is educated and is employed, she also has to fulfill her ascribed role as a woman in addition to her professional work. This can clearly have a negative impact not only on the health status of the mother but also of her

children. Unless gender roles and gender relations are renegotiated, children will continue to suffer.

With an increase in women's education and employment status, especially in urban areas, it can be expected that women will be more capable of providing economic support to their aging parents. This could bring about a change in the attitudes toward women and female children. According to Leela Visaria, "There is evidence of inter-generational tensions and conflicts such that some elderly are beginning to feel that daughters rather than sons are more dependable for emotional and even financial support" (Visaria 1994). It will be interesting to examine in future studies whether these changes have a positive effect in bridging the gap between male and female infant survival in the north and the south and in the rural and urban areas. If such changes can be brought about in the economic and cultural worth of women in India, son preference may indeed become weaker and lead to a reduction of the demographic consequences of such a gender preference. But for now, it can still be concluded that there is a socio- cultural importance attached to the birth of a son in rural India, and this attitude is strongest in the northern states. Most North Indians still pray as the Atharva Veda (one of the ancient Holy Scriptures of India) says: *'the birth of a girl, grant it elsewhere; here grant a boy.'*

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