HEALTH AND ENVIRONMENT

by
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Preface

The National Institute of Public Finance and Policy (NIPFP) is an autonomous non-profit organisation established for carrying out research, undertaking consultancy work and imparting training in the fields of public finance and policy.

In June 1990, the NIPFP with financial support from the Ford Foundation set up a research unit to study 'Health Economics and Financing in India'. The major research concerns in the Health Economics Unit, since then, have been the problems of financing public health expenditure in India in the light of its persistent low health status. The present studies— the final outputs of the unit— are a set of five studies, of which one is devoted to a database on health expenditure of four states of India. Focused mainly on health and environment, these studies examine various aspects of public health care scenarios in the central, state, and union territory levels, as also in some selected countries of the world.

The titles of the studies are:

1. Health and Environment

2. Health Care Status in India.

3. Health Care Systems in India.

4. Health Care Financing Practices in Selected Countries.

5. Database on Health Expenditure: Four Selected States, Volume I and Volume II

The first study was planned and conducted by A.L. Nagar. He was assisted by Harmeet Singh Maddh, Sharmistha Mukherjee, Anindita Chakroborty, Tauhidur Rehman, Rajeev Kumar Singh and Vikram Singh. The studies at 2, 3 and 4 were undertaken by Charu C. Garg, Harmeet Singh Maddh, Ranita Datta and V. Selvaraju. The database is the outcome of an effort made by Charu C. Garg and V. Selvaraju.

The members of the Governing Body of the Institute are not be responsible for the views expressed in these reports. That responsibility belongs to the authors.

Ashok K. Lahiri
Director

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Ms. Sharmistha Mukerjee, Harmeet Singh Maddh, Anindita Chakraborty, and Tauhidur Rehman carried out the sample survey and the tabulation of data was done by Rajeev Kumar Singh and Vikram Singh. At a later stage Ms. Anindita Datta joined us in this effort. I put in my great appreciation for their efficient handling and tabulation of data.

The Part Two of the report was prepared with the help of Mr. Tauhidur Rehman of the Delhi School of Economics. I thank him for providing able assistance in data collection and running relevant computer programmes.

Ms. Usha Mathur helped me a great deal in efficient typing of the manuscript. I appreciate her painstaking efforts always with a smile.

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CHAPTER I

OBJECTIVE OF THE STUDY

The objective of this study is to analyze the effect of environment on the health of a community. We postulate that the health status of a community is a 'conceptual variable' which cannot be measured directly but is indirectly determined by the civic and socioeconomic environment of the people and the physico–natural environment of the region.

At the microlevel, the health status of persons in a household is determined by the income level of the household, their level of education (or, the education level of the head of the household), the occupation of the household, their living condition (kind of housing, number of members in the household, etc.), access to clean drinking water, sanitation facilities and medical infrastructure facilities. The kind of water consumed and air pollution affect the health of persons significantly.

At the macrolevel we may analyse state–wise (or, district–wise) data. The determinants of health status may include the per capita income of the state, level of education of the people of the state (as measured by the number of people with primary or middle school education), per capita state expenditure on health services, inequality of the income distribution in the state (as measured by GINI coefficient or any other suitable measure), the number of persons per primary health centre and per doctor, etc. We may also include a variable like 'number of persons above 60 years of age', as the ageing population is characterized by high morbidity rates lowering the health status of people of the state.

The 'indicators' of health of a community may be:

i the crude death rate, or, cause specific death rates,

ii the infant mortality rate,

iii the expectation of life at birth,

etc. However, we should note that the health status of a community affects the indicator variables, but not vice-versa. We may come across communities with low mortality rates indicating high health status but they may suffer from high morbidity rates (implying poor health status). Similarly communities with high expectation of life at birth may not necessarily have high health status.

In Part A of this study we focus our attention on the health situation in the U.T./N.C.T. of Delhi.

In Chapter II we discuss briefly the demographic features of Delhi and in Chapter III we use mortality data as obtained from the Annual Reports on Registration of Births and Deaths (1984 to 1994) published by the Chief Registrar (Births and Deaths), Government of U.T./N.C.T. of Delhi; and morbidity and mortality data for the years 1993, 1994 and 1995 from various hospitals in Delhi under the Director General of Health Services, Delhi.

We also conducted a sample survey of 291 households from slum and non–slum areas in various clusters of localities in Delhi. The Chapter IV provides the socioeconomic profile of the population of Delhi, sample design and the questionnaire and Chapter V provides the socioeconomic profile of sample households. Finally, the Chapter VI provides the cluster–wise and age–wise distribution of diseases in slum and non–slum areas of U.T./N.C.T. of Delhi according to the sample survey.

In Pat B of the study we analyze state level macro data of health in India. We use data from fifteen states in India for the census years 1971, 1981 and 1991. The Chapter IX provides the method of estimation of community health status index as a weighted average of principal components of variables which are supposed to be causes of changes in the health status index. The Chapter XI provides the computed health status indices for fifteen states of India for 1971, 1981 and 1991 and relationship between health status indices of states and indicators of health are given in Chapter XII.

Part A

MICRO ANALYSIS OF HEALTH SCENARIO IN DELHI USING SECONDARY AND PRIMARY DATA

CHAPTER II

DEMOGRAPHIC FEATURES OF DELHI

Delhi was given the status of part–C state after the adoption of the Constitution of India in 1950. The legislative assembly was formed in 1952. It became the Union Territory (U.T.) of Delhi under the State Reorganisation Act of 1956, and the Metropolitan Council was set up in 1966. The new legislative assembly came into being in 1993 under the National Capital Territory (NCT) Act. It is now referred to as the National Capital Territory of Delhi.

1 Geography of Delhi

Delhi is spread out on the banks of river Yamuna between 28° 24′17" and 28°53′00" of north latitude and 76°50′24" and 77°20′37" of east longitude. It is surrounded by the state of Haryana on three sides and the state of Uttar Pradesh on one side. The district of Sonepat of Haryana is located in the north of Delhi, districts of Gurgaon and Faridabad of Haryana are in the south, the district of Rohtak of Haryana is in the west and districts of Ghaziabad and Noida of Uttar Pradesh are in the east of Delhi.

2 Climate of Delhi

Delhi is rather dry and very hot in summer months of May and June and it is very cold in winter during December and January. The maximum temperature during summer ranges from 40° celsius to 45° celsius, and the lowest in winter from 4° celsius to 9° celsius. The relative humidity during May–August varies from 30% to 80%. The months of July and August witness south–west monsoon which brings moderate to heavy rainfall. About 84% of the total rainfall in the year is during July and August, which amounts to a total of 170 to 220 mm. approximately.

3 Area of Delhi

The maximum length of Delhi is 51.90 kms. and its maximum breadth is 48.48 kms. The total area of Delhi is 1483 sq.kms., of which the urban area is 685.34 sq.kms. and 797.66 sq.kms is rural. Thus 46.21% of the total area of Delhi is urban, where as 53.79% is rural.

4 Civic Bodies of Delhi

The urban Delhi comprises 32 census towns of which 3 are statutory towns and 29 are census towns.

The three statutory towns are

(i) New Delhi Municipal Committee (NDMC)

(ii) Delhi Cantonment (Delhi Cantt)

(iii) Delhi Municipal Corporation (DMC–Urban)

and 29 census towns are

1) Alipur
2) Bawana
3) Pooth Khurd
4) Pehladpur Banger
5) Kanjhawala
6) Bhalswa Jahangirpur
7) Gokalpur
8) Babarpur
9) Jafarabad
10) Ghonda Meewka Banger alias Patpatganj
11) Roshanpura alias Dichaon Khurd
12) Mundka
13) Sultanpur Majra
14) Nangloi Jat
15) Bindapur
16) Nasirpur
17) Palam
18) Nangal Bewat
19) Malikpur Kohi alias Rangpuri
20) Rajokri

21) Ghitorni
22) Yahya Nagar
23) Sultanpur
24) Tigri
25) Deoli
26) Pul Pehlad
27) Taj Pul
28) Molar Band
29) Asola

MCD is the largest municipal body which provides civic services to people in rural as well as urban areas. It provides services to rural and urban villages, resettlement colonies, regularised unauthorised colonies, Jhuggi Jhopri (JJ) squatter settlements, slum basties, private katras, etc.

MCD covers an area of 1397.29 sq. kms which forms 94.22% of the total area of Delhi. MCD (urban) covers 599.63 sq. kms. and MCD (rural) covers 797.66 sq.kms. Thus MCD (urban) has a share of 42.91% of the total area of MCD and MCD (rural) has 57.09%.

The total area covered by the civic body NDMC for providing civic services is 42.74 sq. kms and that by Delhi Cantt. is 42.97 sq.kms. Thus NDMC covers 2.88% and Delhi Cantt. 2.90% of the total area of Delhi.

NDMC and Delhi Cantt. cover only urban areas in Delhi, where as MCD covers both rural and urban areas.

There are 209 villages in rural Delhi which are divided into two tehsils, viz., Delhi and Mehrauli. The villages are covered by five development blocks as follows:

Development Block	No. of Villages
Alipur	53
Kanjhawala	39
Najafgarh	71
Mehrauli	22
Shahadara	24

5 Growth of Population of Delhi

The population of Delhi has grown substantially over the past few decades. It was barely 4 lakhs in 1901 and rose to about 9 lakhs in 1941, 17.44 lakhs in 1951, 26.58 lakhs in 1961, 40.66 lakhs in 1971, 62.20 lakhs in 1981 and 94.20 lakhs in 1991.

The population increased by about 94% during the decade of 1941–1951 and since 1951 the decadal growth has been of the order of 52% to 53%. The partition of India in 1947 and large scale migrations from Pakistan were mainly responsible for high decadal growth during 1941–1951. Later on, since 1951, the economic planning process and resulting rapid developmental activities led to the influx of large number of rural and other migrants seeking employment opportunities in Delhi. Delhi being the capital of the nation and the largest business centre of North India attracted people from all over India and also from neighbouring countries Nepal, Bhutan, Bangladesh etc.

The compound annual growth rate of the population of Delhi has been 4.3069% during 1951–1991. It was 4.3059% between 1951 and 1961, 4.3393% between 1961 and 1971, 4.3442% between 1971 and 1981 and 4.2380% between 1981 and 1991.

The estimates of population from 1951 to 1990, as on 1st March, 1st July and 1st October of each year have been published by the Directorate of Economics and Statistics, NCT of Delhi 1995, in their publication **Population Statistics**. The population projections for the years 1995 to 2010 have also been provided.

PROJECTED MID YEAR POPULATION OF DELHI

Year	Projected Population
1995	1,09,65,200
1996	1,13,55,500
1997	1,17,58,100
1998	1,21,75,000
1999	1,26,06,500
2000	1,30,53,400
2001	1,35,16,000
2002	1,39,89,100
2003	1,44,78,700
2004	1,49,85,400
2005	1,55,09,900
2006	1,60,52,800
2007	1,66,14,600
2008	1,71,96,100
2009	1,77,98,000
2010	1,84,20,900

Source: Registrar General of India

6 Number of Households in Delhi

The total number of households in all statutory towns (viz., DMC–urban, NDMC and Delhi Cantt.) together was 15,28,211 according to 1991 census; of which 14,41,348 were in DMC–urban, 68,120 in NDMC and 18,743 in Delhi Cantt. Thus the average number of persons per household works out to be 5.0 in DMC–urban and Delhi Cantt. where as it is 4.4 in NDMC.

There is a large size of slum population in Delhi. According to the census of India there were about 15 lakh slum dwellers in 1981 and this figure rose to about 18 lakhs in 1991. This constitutes a sizable proportion of the population of Delhi. DMC–urban has been constantly struggling to provide civic amenities to this massive population under various schemes, which include

(i) night shelter for the absolutely shelterless pavement dwellers,

(ii) slum rehousing flats for slum dwellers under slum clearance scheme

(iii) provision of water for jhuggi dwellers and other sanitation facilities

among others.

Among the census towns the highest average number of persons per household was 7.7 in Jafarabad and next to the highest was 7.2 in Yahya Nagar. The lowest average number of persons per household was 4.3 in Taj Pul.

The average number of persons per household in villages of Delhi was generally greater than 5.0 in all development blocks.

7 Density of Population of Delhi

The density of population of the Union Territory of Delhi has increased by about 3.55 times over the last three decades. It was 1,791 persons per sq.km. in 1961, 2,738 in 1971, 4,194 in 1981 and 6,352 in 1991. The increase in the density of urban population has been of the order of 1.71 times, where as that of the rural population 4.61 times. The density of urban population in 1961 was 7,224 persons per sq.km. It rose to 8,172 in 1971, 9,745 in 1981 and 12,361 in 1991. That of the rural population was 258 in 1961, 403 in 1971, 507 in 1981 and 1,190 in 1991.

The DMC (urban) has an area of 431.09 sq.kms. and according to the 1991 census had a population size of 72,06,704. Thus the density of population of DMC (urban) in 1991 works out to be 16,717 persons per sq.km. On the other hand, NDMC and Delhi Cantt. have areas of 42.74 sq.kms. and 42.97 sq. kms., respectively. Their respective population in 1991 were 3,01,297 and 94,393. Therefore, the density of population in NDMC area, in 1991, was 7050 and in Delhi Cantt. it was 2197 persons per sq.km. It turns out that DMC (urban) is the most densely populated statutory town of urban Delhi.

The total area covered by 29 census towns of urban Delhi is 168.54 sq.kms. and their population in 1991 was 8,69,231. The highest density of population among census towns is in Babarpur and minimum in Asola. Babarpur has an area of 0.79 sq.kms. and its 1991 population was 47,451. Hence the density was 60,065 persons per sq.km. Asola, on the other hand, has an area of 11.95 sq.kms. with a population of 5,061 and, therefore, it has the density as low as 424 persons per sq.km. Other census towns with rather high density of population (as of 1991 census) are Sultanpur Majra, Tigri and Nasirpur having densities as 40,277, 32,777 and 28,549 persons per sq. km., respectively.

Among the rural development blocks of Delhi, Shahadara had the highest density of population of 7295 persons per sq.km., while Mehrauli has the lowest density of 814 persons per sq.km. Alipur, Kanjhawala and Najafgarh blocks had densities as 941, 1020 and 921 persons per sq. km. respectively.

The over all population of the entire Union Territory of Delhi was 40,65,698 in 1971, 62,20,406 in 1981 and 94,20,644 in 1991 and its density of population in respective years was 2738, 4194 and 6352. The share of urban population was 89.7% in 1971, 92.7% in 1981 and 89.9% in 1991.

8 Sex Ratio in Delhi

The sex composition of the population is affected by differentials in mortality conditions of males and females, sex ratio at birth and sex selective migration. The sex ratio is defined as the number of females per 1000 males.

While the sex ratio in India has successively declined over years that in Delhi has shown an increasing trend. In Delhi the sex ratio was 801 in 1971, 808 in 1981 and 827 in 1991.

According to the census of India–1991, the sex ratio in the three statutory towns (NDMC, Delhi Cantt. and DMC–urban), all together, was 830 females per 1000 males. The maximum was in DMC–urban with 834 and minimum in Delhi Cantt. with 638 females per 1000 males. The NDMC had 811.

The over all sex ratio for 29 census towns was 823 females per 1000 males; and rural Delhi had 807 females per 1000 males.

9 Literacy Rates in Delhi

The literacy rate in the Union Territory of Delhi increased from 52.7% in 1961 to 75.29% in 1991. It was 56.61% in 1971 and 61.54% in 1981. The literacy rate in urban Delhi increased from 56.2% to 76.18%. It was 56.2% in 1961, 58.95% in 1971, 62.64% in 1981 and 76.18% in 1991. In rural Delhi, the literacy rate was 25.1% in 1961, 36.23% in 1971, 47.56% in 1981 and 66.89% in 1991. (During censuses conducted in 1961, 1971 and 1981 children in the age group 0–4 years were left out for working out literacy rate. However, in 1991 census children in the age group 0–6 were left out).

The over all literacy rate in all statutory towns together (i.e. DMC–urban, NDMC and Delhi Cantt.) was 77.04% according to the 1991 census. It was 82.78% for males and 69.99% for females. The DMC–urban showed a percentage of 76.73 of which 82.47% were males and 69.71% were females; NDMC had 82.44% literacy rate with 87.92% for males and 75.57% for females; and Delhi Cantt. showed 82.86% as literacy rate with 88.65% for males and 73.18% for females.

Generally, the census towns showed a lower rate of literacy. Those which had more than 80% literacy rate for males are:

Asola (83.54), Babarpur (81.32), Bindapur (88.32), Deoli (82.49), Ghitorni (85.04), Malikpur Kohi alias Rangpuri (88.03), Molar Band (86.63), Mundka (84.93), Nasirpur (88.81), Palam (87.75), Pehladpur Bangar (88.95), Roshan Pura alias Dichaon Khurd (87.46), and Yahya Nagar (84.84).

However, in these towns female literacy rate ranged from 46.50% to 70.35%.

The literacy rates in rural Delhi ranged from 60.88% to 73.20%. The male literacy rate was highest at 84.11% in Najafgarh Development Block and next to the highest was in Kanjhawala Development Block at 81.01%. The female literacy rates ranged from 45.47% to 59.63%. The highest being in Najafgarh Development Block and next to the highest in Kanjhawala Development Block as for males.

10 Vital Statistics of Delhi

The data have been published in the **Annual Reports on Registration of Births and Deaths in Delhi** by Directorate of Economics and Statistics and Office of Chief Registrar (Births and Deaths), Delhi.

During the period 1984 to 1994 the **Crude Birth Rate** (defined as the number of births in a year per 1000 of population) in Delhi has varied between 24.77 per 1000 population and 29.00 per 1000 population. It was 27.14 in 1984 and increased to 29.00 in 1990. Since 1990 the crude birth rate has shown a declining trend. It was 28.52 in 1991, 27.76 in 1992, 26.43 in 1993 and 24.77 in 1994.

The **Crude Death Rate** is measured as the number of deaths per 1000 population. During 1984–1994, the crude death rate in Delhi declined from 7.04 in 1984 to 6.44 in 1994. The lowest death rate of 6.26 was recorded in 1990. It was 6.27 in 1992 and 1993.

The **infant mortality rate** defined as number of deaths under one year of age which occurred among 1000 live births has substantially declined from 44.36 in 1984 to 29.55 in 1994. The lowest was 29.08 in 1993.

Sex ratio at birth measured as number of female births per 1000 male births has shown a declining trend during 1989 to 1994. It was 885 in 1989, 883 in 1990, 867 in 1991, 862 in 1992, 856 in 1993 and 840 in 1994.

Sex ratio at death measured as the number of female deaths per 1000 male deaths was 598 in 1992, 612 in 1993 and 614 in 1994. It fluctuated between 487 in 1987 and 614 in 1994.

11 Medical and Public Health Infrastructure of Delhi

Expenditure on Medical, Public Health and Family Welfare

As per the Memorandum of the Government of NCT of Delhi to Delhi Finance Commission–1997, the total annual plan and non–plan expenditure of the Government of the National Capital Territory of Delhi on medical, public health and family welfare services increased from Rs 3.269 lakhs in 1985–86 to Rs 19,384 lakhs in 1995–96. The plan component of the expenditure on medical and public health services was Rs 1,013 lakhs in 1985–86 and this rose to Rs 6,414 lakhs in 1995–96; and the corresponding non–plan expenditure rose from Rs 2,256 lakhs in 1985–86 to Rs 11,470 lakhs in 1995–96. An additional expenditure of Rs 1,500 lakhs on family welfare was provided for in 1995–96.

The budget papers of MCD and NDMC provide their annual expenditure on medical and public health services for various years.

As per the budget papers of MCD the total expenditure on medical relief and public health by MCD was Rs 1,965.58 lakhs in 1985–86 and this rose to Rs 7,435.94 lakhs in 1995–96. An additional capital expenditure of Rs 492.35 lakhs for medical relief was provided for by MCD in 1995–96.

The budget papers of NDMC show their total expenditure on medical and public health and family planning as Rs 537.73 lakhs in 1985–86 and Rs 2,562.57 lakhs in 1995–96. The component of expenditure on medical and pubic health in 1995–96 was Rs 2,555.01 lakhs and that on family planning was Rs 7.56 lakhs.

The expenditure on medical services and sanitation by Delhi Cantonment was Rs 75.68 lakhs in 1985–86 and this rose to Rs 277.21 lakhs in 1995–96. The source of this information is the **Statistical Handbook** at the Directorate of Economics and Statistics of the Government of NCT of Delhi.

CHAPTER III

MORBIDITY AND MORTALITY EXPERIENCE OF THE U.T./N.C.T. OF DELHI

1 MORTALITY EXPERIENCE OF THE U.T./N.C.T. OF DELHI OVER THE YEARS 1984 TO 1994

Detailed year–wise statistics of medically certified deaths in Delhi by cause, age and sex have been published in the **Annual Reports on Registration of Births and Deaths** by the Directorate of Economics and Statistics and the Office of the Chief Registrar (Births and Deaths), Government of the National Capital Territory (NCT) of Delhi; and the estimated mid–year population of Delhi in the corresponding years have been published in **Population Statistics of NCT of Delhi** by the Directorate of Economics and Statistics, Government of the NCT of Delhi.

The Table 1 provides the distribution of number of male and female deaths in Delhi over the years 1984 to 1994. The causes of death have been classified as:

I. Communicable Diseases, Maternal, Perinatal and Nutritional Conditions
II. Non–Communicable Diseases
III. Injuries/Accidents
IV. Others
V. Unclassified deaths

The last row of Table 1 provides the estimated mid–year population of Delhi in successive years.

In the Table 2 we obtain the ratios of 'the number of deaths due to a specified cause' to 'the total number of deaths in that category' in a particular year expressed in percentage terms.

The Table 3 provides the ratios of 'the number of deaths due to a specified cause' to 'the total number of deaths in a given year', expressed in percentage terms.

Finally, the Table 4 provides the cause specific death rates per 1,00,000 of population. These have been calculated as the ratio of 'number of deaths due to a specified cause in a year' to 'the estimated mid–year population of that year' multiplied by 1,00,000. The last row of this table provides the over all crude death rates per 1,00,000 of population in successive years, calculated as the ratio of 'total number of deaths in a year' to 'the estimated mid–year population of that year' multiplied by 1,00,000.

We observe from Tables 1 and 2 that a substantial proportion of deaths have not been classified as due to any specified cause. The percent of deaths not elsewhere classified in successive years 1984 to 1994 are

65.97, 63.25, 59.03, 62.45, 71.43, 70.19, 57.72, 51.18, 55.66, 53.45, 52.08,

respectively. They range from the lowest of 51.18% i n 1991 to the largest of 71.43% in 1988.

The diseases

i tuberculosis

ii heart diseases and heart attacks

iii certain conditions such as birth injuries, slow growth of foetus and premature originating in perinatal period

claimed a heavy toll.

As it appears from Table 3, the percent of deaths due to 'tuberculosis' in successive years 1984 to 1994 were

4.64, 4.23, 4.71, 4.39, 4.51, 4.14, 5.01, 5.86, 5.83, 6.10, 6.07,

respectively; and those due to heart diseases and heart attacks were

3.87, 6.94, 10.34, 4.41, 3.23, 3.84, 8.12, 9.41, 8.25, 8.21, 8.35

respectively.

The percent of deaths due to tuberculosis ranged from the lowest of 4.14% in 1989 to the largest of 6.10% in 1993; where as heart diseases and heart attacks claimed the lowest of 3.23% in 1988 to the largest of 10.34% in 1986. Barring minor fluctuations, one can notice a rising tendency in proportion of deaths due to these diseases. We can attribute this to worsening living conditions, increasing stress and tension in life and deteriorating environmental conditions in the city due to increase in density of population, air and water pollution and congestion in localities.

The percent of deaths due to certain conditions such as birth injuries, slow growth of foetus and premature originating in perinatal period in successive years were

9.47, 8.78, 9.57, 6.71, 5.47, 6.00, 6.85, 8.00, 8.53, 7.43, 5.88,

respectively; the lowest percent being 5.47 in 1988 and the highest 9.57 in 1986.

Delhi witnesses a large number of cases every year of cholera, food poisoning, dysentery, diarrhoea, gastroenteritis, measles, malaria, pneumonia, influenza, bronchitis and asthma, jaundice, etc., although the number of deaths due to these causes is rather few; see Table 1 and 3. Most of these diseases occur seasonally among the lower socio–economic groups of people who live in rather sub–human conditions in poor hutments, unauthorised colonies, village extensions, jhuggi–jhopari (JJ) and resettlement colonies which are characterized by most unhygienic living conditions. The diseases are mostly water borne and viral. In these localities there is very poor supply of clean drinking water, the main supply being from 'shallow' hand pumps. The supply of drinking water through tankers and running

water taps is either non–existent or highly inadequate and scarce. Cholera is transmitted through intake of contaminated water or eating uncooked food, raw vegetables and cut fruits which may have been contaminated by dirty water, soiled hands or flies. Unhygienic living conditions and intake of contaminated food and water are also responsible for typhoid and paratyphoid fevers, food poisoning, dysentery, diarrhoea and gastroenteritis. Malaria is caused by infective mosquito bite. Improvement of sanitation and filling and draining of stagnant water is the required preventive measure, besides spraying of living quarters and use of mosquito repellents.

We observe from Table 2 that there are fluctuations in the proportion of deaths due to communicable diseases and other causes included in the category I, but the proportion of deaths due to non–communicable diseases included in category II show a rising tendency. As shown in Table 2, the percent of deaths due to communicable diseases, maternal perinatal and nutritional conditions in successive years are

19.59, 19.69, 20.98, 19.94, 18.41, 18.78, 20.57, 23.32, 22.22, 21.82, 20.98

and percent of deaths due to non–communicable diseases are

7.25, 10.47, 14.25, 9.36, 5.94, 6.61, 13.66, 15.90, 14.04, 16.60, 17.38.

Among the non–communicable diseases 'cancer' appears to have rising tendency over years. The percent of deaths due to cancer among all deaths in respective years 1984 to 1994 were

0.48, 0.45, 0.55, 1.18, 0.47, 1.09, 1.87, 2.39, 2.03, 2.38, 2.77;

and the cause specific death rates (due to cancer) in these years were:

3.393, 3.013, 3.481, 7.752, 3.170, 7.312, 11.733, 15.212, 12.704, 14.946, 17.860;

see Table 4.

TABLE 1

MORTALITY EXPERIENCE OF U.T./N.C.T. OF DELHI - 1984 TO 1994
NUMBER OF DEATHS DUE TO VARIOUS CAUSES

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	**COMMUNICABLE DISEASES, MATERNAL, PERINATAL AND NUTRITIONAL CONDITIONS**	**Male**	**6084**	**6047**	**6256**	**6590**	**6572**	**6839**	**7267**	**8811**	**8589**	**8746**	**8956**
		Female	**3784**	**3817**	**4104**	**4030**	**3986**	**4214**	**4542**	**5320**	**5168**	**5240**	**5343**
		Total	**9868**	**9864**	**10360**	**10620**	**10558**	**11053**	**11809**	**14131**	**13757**	**13986**	**14299**
1	Cholera	Male	0	0	1	0	0	1	0	1	0	0	0
		Female	0	0	0	1	0	0	0	2	0	0	0
		Total	0	0	1	1	0	1	0	3	0	0	0
2	Typhoid and Para Typhoid	Male	38	20	6	6	13	15	30	103	148	31	58
		Female	27	10	5	2	5	7	24	86	73	38	49
		Total	65	30	11	8	18	22	54	189	221	69	107
3	Dysentery, diarrhoea and Gastro Enteritis	Male	403	436	508	647	775	861	537	422	387	438	537
		Female	347	365	385	536	577	595	442	329	341	318	427
		Total	750	801	893	1183	1352	1456	979	751	728	756	964
4	Tuberculosis	Male	1633	1489	1617	1686	1875	1704	1992	2439	2471	2648	2914
		Female	703	632	707	652	713	730	882	1110	1138	1260	1225
		Total	2336	2121	2324	2338	2588	2434	2874	3549	3609	3908	4139
5	Leprosy	Male	1	4	1	2	2	2	2	6	2	27	7
		Female	0	1	0	1	1	2	2	2	5	13	2
		Total	1	5	1	3	3	4	4	8	7	40	9
6	Diptheria	Male	35	27	41	58	75	76	72	39	48	38	28
		Female	16	25	32	18	47	40	46	30	36	27	24
		Total	51	52	73	76	122	116	118	69	84	65	52
7	Whooping Cough	Male	0	4	3	4	2	9	2	0	2	2	5
		Female	0	0	0	1	2	5	2	1	5	3	2
		Total	0	4	3	5	4	14	4	1	7	5	7

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
8	Tetanus	Male	101	120	115	258	165	168	210	116	83	96	85
		Female	55	76	46	206	92	97	84	46	39	34	32
		Total	156	196	161	464	257	265	294	162	122	130	117
9	Poliomyelitis	Male	11	16	11	22	45	25	54	49	25	36	56
		Female	0	16	11	14	16	9	25	12	9	16	17
		Total	11	32	22	36	61	34	79	61	34	52	73
10	Measles	Male	43	73	65	66	119	92	83	60	49	24	33
		Female	36	74	56	67	123	95	77	70	54	30	64
		Total	79	147	121	133	242	187	160	130	103	54	97
11	Rabies	Male	9	14	23	15	24	26	17	28	17	24	26
		Female	1	2	1	4	3	3	4	6	6	8	17
		Total	10	16	24	19	27	29	21	34	23	32	43
12	Malaria	Male	46	44	27	14	36	35	59	82	77	55	73
		Female	21	31	14	8	27	15	36	50	43	35	39
		Total	67	75	41	22	63	50	95	132	120	90	112
13	Anaemia	Male	141	128	97	369	164	107	304	487	374	490	506
		Female	207	145	91	302	167	115	299	512	380	548	527
		Total	348	273	188	671	331	222	603	999	754	1038	1033
14	Meningitis	Male	220	483	396	594	436	453	496	425	521	600	539
		Female	143	249	201	399	262	271	327	255	330	333	361
		Total	363	732	597	993	698	724	823	680	851	933	900
15	Pneumonia	Male	327	318	281	372	486	522	627	1033	812	845	896
		Female	213	211	168	223	262	353	438	611	559	519	606
		Total	540	529	449	595	748	875	1065	1644	1371	1364	1502
16	Influenza	Male	0	0	0	0	0	0	0	0	1	1	4
		Female	0	0	1	0	0	0	0	0	1	1	2
		Total	0	0	1	0	0	0	0	0	2	2	6

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
17	Jaundice	Male	13	10	12	156	362	448	291	397	155	257	304
		Female	6	3	18	104	212	332	218	260	137	221	311
		Total	19	13	30	260	574	780	509	657	292	478	615
18	Syphillis and Other Diseases of Genitourinary System	Male	50	149	321	72	151	149	66	57	52	83	260
		Female	18	94	253	29	77	81	49	29	14	33	150
		Total	68	243	574	101	228	230	115	86	66	116	410
19	Abortion	Male	0	0	0	0	0	0	0	0	0	0	0
		Female	12	16	12	8	3	1	11	16	9	11	15
		Total	12	16	12	8	3	1	11	16	9	11	15
20	Complications Related to Pregnancy, Child Birth, Puerperium	Male	0	0	0	0	0	0	0	0	0	0	0
		Female	219	178	110	128	100	79	70	113	70	83	87
		Total	219	178	110	128	100	79	70	113	70	83	87
21	Certain Conditions Such as Birth Injuries, Slow Growth of Foetus and Premature Originating In Perinatal Period	Male	3013	2712	2731	2249	1842	2146	2425	3067	3365	3051	2625
		Female	1760	1689	1993	1327	1297	1384	1506	1780	1919	1709	1386
		Total	4773	4401	4724	3576	3139	3530	3931	4847	5284	4760	4011
II	**NON COMMUNICABLE DISEASES**	**Male**	**2408**	**3457**	**4597**	**3288**	**2345**	**2558**	**5121**	**6339**	**5731**	**6726**	**7739**
		Female	**1243**	**1788**	**2441**	**1696**	**1064**	**1331**	**2720**	**3295**	**2963**	**3916**	**4106**
		Total	**3651**	**5245**	**7038**	**4984**	**3409**	**3889**	**7841**	**9634**	**8694**	**10642**	**11845**
1	Cancer	Male	150	146	160	386	158	419	601	865	727	881	1131
		Female	93	79	111	243	110	225	475	586	527	647	760
		Total	243	225	271	629	268	644	1076	1451	1254	1528	1891
2	Diabetes Mellitus	Male	162	191	182	260	300	218	331	419	414	416	507
		Female	129	125	138	181	166	187	263	292	320	327	391
		Total	291	316	320	441	466	405	594	711	734	743	898

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	Heart Diseases and Heart Attacks	Male	1284	2289	3369	1534	1258	1527	3148	3778	3416	3355	3876
		Female	665	1186	1738	814	594	735	1511	1923	1690	1910	1816
		Total	1949	3475	5107	2348	1852	2262	4659	5701	5106	5265	5692
4	Chronic Liver Diseases and Cirrhosis	Male	205	225	293	444	194	143	271	318	364	611	654
		Female	116	152	162	263	75	52	114	65	91	235	270
		Total	321	377	455	707	269	195	385	383	455	846	924
5	Ulcer of Stomach and Duodenum	Male	13	32	19	6	1	0	2	13	15	9	17
		Female	6	8	6	3	1	0	0	7	5	4	12
		Total	19	40	25	9	2	0	2	20	20	13	29
6	Appendicitis	Male	76	79	64	1	0	0	1	2	18	5	4
		Female	30	43	50	1	0	0	1	2	9	2	3
		Total	106	122	114	2	0	0	2	4	27	7	7
7	Cerebrovascular (Paralysis)	Male	32	13	94	8	2	0	68	77	51	628	587
		Female	16	6	54	1	0	0	36	50	38	449	434
		Total	48	19	148	9	2	0	104	127	89	1077	1021
8	Bronchitis and Asthma	Male	484	438	363	647	431	250	698	756	700	800	962
		Female	187	147	142	190	118	131	320	301	272	336	419
		Total	671	585	505	837	549	381	1018	1057	972	1136	1381
9	Senility	Male	2	44	53	2	1	1	1	111	26	21	1
		Female	1	42	40	0	0	1	0	69	11	6	1
		Total	3	86	93	2	1	2	1	180	37	27	2
III	**INJURIES/ACCIDENTS**	**Male**	**2635**	**2338**	**1728**	**2922**	**1575**	**1589**	**3044**	**3855**	**3367**	**3421**	**4347**
		Female	**993**	**966**	**1104**	**1473**	**835**	**1009**	**1576**	**1962**	**1637**	**1786**	**2170**
		Total	**3628**	**3304**	**2832**	**4395**	**2410**	**2598**	**4620**	**5817**	**5004**	**5207**	**6517**
1	Bites and stings of Venomous Animals	Male	1	2	3	0	0	0	0	116	196	158	0
		Female	2	2	1	0	0	0	0	73	125	98	0
		Total	3	4	4	0	0	0	0	189	321	256	0

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
2	Accidental Burns	Male	320	311	379	840	524	538	470	597	482	554	600
		Female	625	590	725	568	565	687	937	1059	855	998	1101
		Total	945	901	1104	1408	1089	1225	1407	1656	1337	1552	1701
3	Falls, Drowning	Male	71	92	96	207	56	0	251	209	201	208	214
		Female	34	40	40	95	31	0	57	95	88	76	96
		Total	105	132	136	302	87	0	308	304	289	284	310
4	Accidental Poisoning (other than food poisoning)	Male	70	76	56	149	111	85	140	311	86	113	154
		Female	26	36	26	88	50	94	69	100	35	54	82
		Total	96	112	82	237	161	179	209	411	121	167	236
5	Transport (Traffic) Accident (Involving Railways, Aircraft,Motor vehicles, Animal being ridden or driving vehicles).	Male	341	276	333	694	201	122	915	969	801	1036	1109
		Female	48	46	65	263	47	24	192	163	129	198	193
		Total	389	322	398	957	248	146	1107	1132	930	1234	1302
6	Other Accidents Not Elsewhere Classified	Male	814	718	755	917	627	822	1090	1357	1316	1063	1925
		Female	161	149	203	366	137	195	235	305	280	230	543
		Total	975	867	958	1283	764	1017	1325	1662	1596	1293	2468
7	Suicide	Male	46	43	21	20	21	9	107	160	145	135	175
		Female	25	30	26	8	1	6	58	106	79	68	82
		Total	71	73	47	28	22	15	165	266	224	203	257
8	Homicide	Male	972	820	85	95	35	13	71	136	140	154	170
		Female	72	73	18	85	4	3	28	61	46	64	73
		Total	1044	893	103	180	39	16	99	197	186	218	243
IV	**OTHERS**	**Male**	**0**	**0**	**0**	**2**	**4**	**0**	**0**	**0**	**2**	**2**	**2**
		Female	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**	**1**	**3**	**2**
		Total	**0**	**0**	**0**	**2**	**4**	**2**	**1**	**1**	**3**	**5**	**4**

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	Food Processing	Male	0	0	0	2	4	0	0	0	2	2	2
		Female	0	0	0	0	0	2	1	1	1	3	2
		Total	0	0	0	2	4	2	1	1	3	5	4
V	UNCLASSIFIED DEATHS	Male	20235	19994	19118	23009	27472	25848	20121	18823	21053	20864	21179
		Female	13002	11700	10029	10256	13490	15450	13011	12194	13411	13402	14324
		Total	33237	31694	29147	33265	40962	41298	33132	31017	34464	34266	35503
	TOTAL	Male	31362	31836	31699	35811	37968	36834	35553	37828	38742	39759	42223
		Female	19022	18271	17678	17455	19375	22006	21850	22772	23180	24347	25945
		Total	50384	50107	49377	53266	57343	58849	57403	60600	61922	64106	68168
	ESTIMATED MID YEAR POPULATION	TOTAL	7161600	7467700	7785100	8114000	8454700	8806900	9170900	9538300	9871100	10223200	10587700

Source: ANNUAL REPORTS OF BIRTH AND DEATH REGISTRAR FROM 1984 TO 1994. DIRECTORATE OF ECONOMICS AND STATISTICS, GOVERNMENT OF NCT OF DELHI

MID YEAR POPULATION - POPULATION STATISTICS, DIRECTORATE OF ECONOMICS AND STATISTICS, DELHI GOVERNMENT

TABLE 2

MORTALITY EXPERIENCE OF U.T./N.C.T. OF DELHI - 1984 TO 1994
NUMBER OF CAUSE SPECIFIC DEATHS AS A PERCENT OF TOTAL NUMBER OF DEATHS IN A GIVEN CATEGORY

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	**COMMUNICABLE DISEASES, MATERNAL, PERINATAL AND NUTRITIONAL CONDITIONS**	**Male**	**19.40**	**18.99**	**19.74**	**18.40**	**17.31**	**18.57**	**20.44**	**23.29**	**22.17**	**22.00**	**21.21**
		Female	**19.89**	**20.89**	**23.22**	**23.09**	**20.57**	**19.15**	**20.79**	**23.36**	**22.30**	**21.52**	**20.59**
		Total	**19.59**	**19.69**	**20.98**	**19.94**	**18.41**	**18.78**	**20.57**	**23.32**	**22.22**	**21.82**	**20.98**
1	Cholera	Male	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
		Female	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.04	0.00	0.00	0.00
		Total	0.00	0.00	0.01	0.01	00.0	0.01	0.00	0.02	0.00	0.00	0.00
2	Typhoid and Para Typhoid	Male	0.62	0.33	0.10	0.09	0.20	0.22	0.41	1.17	1.72	0.35	0.65
		Female	0.71	0.26	0.12	0.05	0.13	0.17	0.53	1.62	1.41	0.73	0.92
		Total	0.66	0.30	0.11	0.08	0.17	0.20	0.46	1.34	1.61	0.49	0.75
3	Dysentery, diarrhoea and Gastro Enteritis	Male	6.62	7.21	8.12	9.82	11.79	12.59	7.39	4.79	4.51	5.01	6.00
		Female	9.17	9.56	9.38	13.30	14.48	14.12	9.73	6.18	6.60	6.07	7.99
		Total	7.60	8.12	8.62	11.14	12.81	13.17	8.29	5.31	5.29	5.41	6.74
4	Tuberculosis	Male	26.84	24.62	25.85	25.58	28.53	24.92	27.41	27.68	28.77	30.28	32.54
		Female	18.58	16.56	17.23	16.18	17.89	17.32	19.42	20.86	22.02	24.05	22.93
		Total	23.67	21.50	22.43	22.02	24.51	22.02	24.34	25.11	26.23	27.94	28.95
5	Leprosy	Male	0.02	0.07	0.02	0.03	0.03	0.03	0.03	0.07	0.02	0.31	0.08
		Female	0.00	0.03	0.00	0.02	0.03	0.05	0.04	0.04	0.10	0.25	0.04
		Total	0.01	0.05	0.01	0.03	0.03	0.04	0.03	0.06	0.05	0.29	0.06
6	Diptheria	Male	0.58	0.45	0.66	0.88	1.14	1.11	0.99	0.44	0.56	0.43	0.31
		Female	0.42	0.65	0.78	0.45	1.18	0.95	1.01	0.56	0.70	0.52	0.45
		Total	0.52	0.53	0.70	0.72	1.16	1.05	1.00	0.49	0.61	0.46	0.36
7	Whooping Cough	Male	0.00	0.07	0.05	0.06	0.03	0.13	0.03	0.00	0.02	0.02	0.06
		Female	0.00	0.00	0.00	0.02	0.05	0.12	0.04	0.02	0.10	0.06	0.04
		Total	0.00	0.04	0.03	0.05	0.04	0.13	0.03	0.01	0.05	0.04	0.05

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
8	Tetanus	Male	1.66	1.98	1.84	3.92	2.51	2.46	2.89	1.32	0.97	1.10	0.95
		Female	1.45	1.99	1.12	5.11	2.31	2.30	1.85	0.86	0.75	0.65	0.60
		Total	1.58	1.99	1.55	4.37	2.43	2.40	2.49	1.15	0.89	0.93	0.82
9	Poliomyelitis	Male	0.18	0.26	0.18	0.33	0.68	0.37	0.74	0.56	0.29	0.41	0.63
		Female	0.00	0.42	0.27	0.35	0.40	0.21	0.55	0.23	0.17	0.31	0.32
		Total	0.11	0.32	0.21	0.34	0.58	0.31	0.67	0.43	0.25	0.37	0.51
10	Measles	Male	0.71	1.21	1.04	1.00	1.81	1.35	1.14	0.68	0.57	0.27	0.37
		Female	0.95	1.94	1.36	1.66	3.09	2.25	1.70	1.32	1.04	0.57	1.20
		Total	0.80	1.49	1.17	1.25	2.29	1.69	1.35	0.92	0.75	0.39	0.68
11	Rabies	Male	0.15	0.23	0.37	0.23	0.37	0.38	0.23	0.32	0.20	0.27	0.29
		Female	0.03	0.05	0.02	0.10	0.08	0.07	0.09	0.11	0.12	0.15	0.32
		Total	0.10	0.16	0.23	0.18	0.26	0.26	0.18	0.24	0.17	0.23	0.30
12	Malaria	Male	0.76	0.73	0.43	0.21	0.55	0.51	0.81	0.93	0.90	0.63	0.82
		Female	0.55	0.81	0.34	0.20	0.68	0.36	0.79	0.94	0.83	0.67	0.73
		Total	0.68	0.76	0.40	0.21	0.60	0.45	0.80	0.93	0.87	0.64	0.78
13	Anaemia	Male	2.32	2.12	1.55	5.60	2.50	1.56	4.18	5.53	4.35	5.60	5.65
		Female	5.47	3.80	2.22	7.49	4.19	2.73	6.58	9.62	7.35	10.46	9.86
		Total	3.53	2.77	1.81	6.32	3.14	2.01	5.11	7.07	5.48	7.42	7.22
14	Meningitis	Male	3.62	7.99	6.33	9.01	6.63	6.62	6.83	4.82	6.07	6.86	6.02
		Female	3.78	6.52	4.90	9.90	6.57	6.43	7.20	4.79	6.39	6.35	6.76
		Total	3.68	7.42	5.76	9.35	6.61	6.55	6.97	4.81	6.19	6.67	6.29
15	Pneumonia	Male	5.37	5.26	4.49	5.64	7.40	7.63	8.63	11.72	9.45	9.66	10.00
		Female	5.63	5.53	4.09	5.53	6.57	8.38	9.64	11.48	10.82	9.90	11.34
		Total	5.47	5.36	4.33	5.60	7.08	7.92	9.02	11.63	9.97	9.75	10.50
16	Influenza	Male	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04
		Female	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.04
		Total	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
17	Jaundice	Male	0.21	0.17	0.19	2.37	5.51	6.55	4.00	4.51	1.80	2.94	3.39
		Female	0.16	0.08	0.44	2.58	5.32	7.88	4.80	4.89	2.65	4.22	5.82
		Total	0.19	0.13	0.29	2.45	5.44	7.06	4.31	4.65	2.12	3.42	4.30
18	Syphillis and Other Diseases of Genitourinary System	Male	0.82	2.46	5.13	1.09	2.30	2.18	0.91	0.6 5	0.61	0.95	2.90
		Female	0.48	2.46	6.16	0.72	1.93	1.92	1.08	0.55	0.27	0.63	2.81
		Total	0.69	2.46	5.54	0.95	2.16	2.08	0.97	0.61	0.48	0.83	2.87
19	Abortion	Male	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Female	0.32	0.42	0.29	0.20	0.08	0.02	0.24	0.30	0.17	0.21	0.28
		Total	0.12	0.16	0.12	0.08	0.03	0.01	0.09	0.11	0.07	0.08	0.10
20	Complications Related to Pregnancy, Child Birth, Puerperium	Male	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Female	5.79	4.66	2.68	3.18	2.51	1.87	1.54	2.12	1.35	1.58	1.63
		Total	2.22	1.80	1.06	1.21	0.95	0.71	0.59	0.80	0.51	0.59	0.61
21	Certain Conditions Such as Birth Injuries, Slow Growth of Foetus and Premature Originating In Perinatal Period	Male	49.52	44.85	43.65	34.13	28.03	31.38	33.37	34.81	39.18	34.88	29.31
		Female	46.51	44.25	48.56	32.93	32.54	32.84	33.16	33.46	37.13	32.61	25.94
		Total	48.37	44.62	45.60	33.67	29.73	31.94	33.29	34.30	38.41	34.03	28.05
II	**NON COMMUNICABLE DISEASES**	**Male**	**7.68**	**10.86**	**14.50**	**9.18**	**6.18**	**6.94**	**14.40**	**16.76**	**14.79**	**16.92**	**18.33**
		Female	**6.53**	**9.79**	**13.81**	**9.72**	**5.49**	**6.05**	**12.45**	**14.47**	**12.78**	**16.08**	**15.83**
		Total	**7.25**	**10.47**	**14.25**	**9.36**	**5.94**	**6.61**	**13.66**	**15.90**	**14.04**	**16.60**	**17.38**
1	Cancer	Male	6.23	4.22	3.48	11.74	6.74	16.38	11.74	13.65	12.69	13.10	14.61
		Female	7.48	4.42	4.55	14.33	10.34	16.90	17.46	17.78	17.79	16.52	18.51
		Total	6.66	4.29	3.85	12.62	7.86	16.56	13.72	15.06	14.42	14.36	15.96
2	Diabetes Mellitus	Male	6.73	5.53	3.96	7.91	12.79	8.52	6.46	6.61	7.22	6.18	6.55
		Female	10.38	6.99	5.65	10.67	15.60	14.05	9.67	8.86	10.80	8.35	9.52
		Total	7.97	6.02	4.55	8.85	13.67	10.41	7.58	7.38	8.44	6.98	7.58

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	Heart Diseases and Heart Attacks	Male	53.32	66.21	73.29	46.65	53.65	59.70	61.47	59.60	59.61	49.88	50.08
		Female	53.50	66.33	71.20	48.00	55.83	55.22	55.55	58.36	57.04	48.77	44.23
		Total	53.38	66.25	72.56	47.11	54.33	58.16	59.42	59.18	58.73	49.47	48.05
4	Chronic Liver Diseases and Cirrhosis	Male	8.51	6.51	6.37	13.50	8.27	5.59	5.29	5.02	6.35	9.08	8.45
		Female	9.33	8.50	6.64	15.51	7.05	3.91	4.19	1.97	3.07	6.00	6.58
		Total	8.79	7.19	6.46	14.19	7.89	5.01	4.91	3.98	5.23	7.95	7.80
5	Ulcer of Stomach and Duodenum	Male	0.54	0.93	0.41	0.18	0.04	0.00	0.04	0.21	0.26	0.13	0.22
		Female	0.48	0.45	0.25	0.18	0.09	0.00	0.00	0.21	0.17	0.10	0.29
		Total	0.52	0.76	0.36	0.18	0.06	0.00	0.03	0.21	0.23	0.12	0.24
6	Appendicitis	Male	3.16	2.29	1.39	0.03	0.00	0.00	0.02	0.03	0.31	0.07	0.05
		Female	2.41	2.40	2.05	0.06	0.00	0.00	0.04	0.06	0.30	0.05	0.07
		Total	2.90	2.33	1.62	0.04	0.00	0.00	0.03	0.04	0.31	0.07	0.06
7	Cerebrovascular (Paralysis)	Male	1.33	0.38	2.04	0.24	0.09	0.00	1.33	1.21	0.89	9.34	7.58
		Female	1.29	0.34	2.21	0.06	0.00	0.00	1.32	1.52	1.28	11.47	10.57
		Total	1.31	0.36	2.10	0.18	0.06	0.00	1.33	1.32	1.02	10.12	8.62
8	Bronchitis and Asthma	Male	20.10	12.67	7.90	19.68	18.38	9.77	13.63	11.93	12.21	11.89	12.43
		Female	15.04	8.22	5.82	11.20	11.09	9.84	11.76	9.14	9.18	8.58	10.20
		Total	18.38	11.15	7.18	16.79	16.10	9.80	12.98	10.97	11.18	10.67	11.66
9	Senility	Male	0.08	1.27	1.15	0.06	0.04	0.04	0.02	1.75	0.45	0.31	0.01
		Female	0.08	2.35	1.64	0.00	0.00	0.08	0.00	2.09	0.37	0.15	0.02
		Total	0.08	1.64	1.32	0.04	0.03	0.05	0.01	1.87	0.43	0.25	0.02
III	**INJURIES/ACCIDENTS**	**Male**	**8.40**	**7.34**	**5.45**	**8.16**	**4.15**	**4.31**	**8.56**	**10.19**	**8.69**	**8.60**	**10.30**
		Female	**5.22**	**5.29**	**6.25**	**8.44**	**4.31**	**4.59**	**7.21**	**8.62**	**7.06**	**7.34**	**8.36**
		Total	**7.20**	**6.59**	**5.74**	**8.25**	**4.20**	**4.42**	**8.05**	**9.60**	**8.08**	**8.12**	**9.56**
1	Bites and stings of Venomous Animals	Male	0.04	0.09	0.17	0.00	0.00	0.00	0.00	3.01	5.82	4.62	0.00
		Female	0.20	0.21	0.09	0.00	0.00	0.00	0.00	3.72	7.64	5.49	0.00
		Total	0.08	0.12	0.14	0.00	0.00	0.00	0.00	3.25	6.41	4.92	0.00

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
2	Accidental Burns	Male	12.11	13.30	21.93	28.75	33.27	33 86	15.44	15.49	14.32	16.19	13.80
		Female	62.94	61.08	65.67	38.56	67.66	68.09	59.45	53.98	52.23	55.88	50.74
		Total	26.05	27.27	38.98	32.04	45.19	47.15	30.45	28.47	26.72	29.81	26.10
3	Falls, Drowning	Male	2.69	3.93	5.56	7.08	3.56	0.00	8.25	5.42	5.97	6.08	4.92
		Female	3.42	4.14	3.62	6.45	3.71	0.00	3.62	4.84	5.38	4.26	4.42
		Total	2.89	4.00	4.80	6.87	3.61	0.00	6.67	5.23	5.78	5.45	4.76
4	Accidental Poisoning (other than food poisoning)	Male	2.66	3.25	3.24	5.10	7.05	5.35	4.60	8.07	2.55	3.30	3.54
		Female	2.62	3.73	2.36	5.97	5.99	9.32	4.38	5.10	2.14	3.02	3.78
		Total	2.65	3.39	2.90	5.39	6.68	6.89	4.52	7.07	2.42	3.21	3.62
5	Transport (Traffic) Accident (Involving Railways, Aircraft,Motor vehicles, Animal being ridden or driving vehicles).	Male	12.94	11.80	19.27	23.75	12.76	7.68	30.06	25.14	23.79	30.28	25.51
		Female	4.83	4.76	5.89	17.85	5.63	2.38	12.18	8.31	7.88	11.09	8.89
		Total	10.72	9.75	14.05	21.77	10.29	5.62	23.96	19.46	18.59	23.70	19.98
6	Other Accidents Not Elsewhere Classified	Male	30.89	30.71	43.69	31.38	39.81	51.73	35.81	35.20	39.09	31.07	44.28
		Female	16.21	15.42	18.39	24.85	16.41	19.33	14.91	15.55	17.10	12.88	25.02
		Total	26.87	26.24	33.83	29.19	31.70	39.15	28.68	28.57	31.89	24.83	37.87
7	Suicide	Male	1.75	1.84	1.22	0.68	1.33	0.57	3.52	4.15	4.31	3.95	4.03
		Female	2.52	3.11	2.36	0.54	0.12	0.59	3.68	5.40	4.83	3.81	3.78
		Total	1.96	2.21	1.66	0.64	0.91	0.58	3.57	4.57	4.48	3.90	3.94
8	Homicide	Male	36.89	35.07	4.92	3.25	2.22	0.82	2.33	3.53	4.16	4.50	3.91
		Female	7.25	7.56	1.63	5.77	0.48	0.30	1.78	3.11	2.81	3.58	3.36
		Total	28.78	27.03	3.64	4.10	1.62	0.62	2.14	3.39	3.72	4.19	3.73
IV	**OTHERS**	**Male**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**
	FOOD POISONING	**Female**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**
		Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**

	DISEASES	SEX	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	Food Processing	Male	100.00	100 00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		Female	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		Total	100.00	100 00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
V	**UNCLASSIFIED DEATHS**	**Male**	**64.52**	**62.80**	**60.31**	**64.25**	**72.36**	**70.17**	**56.59**	**49.76**	**54.34**	**52.48**	**50.16**
		Female	**68.35**	**64.04**	**56.73**	**58.76**	**69.63**	**70.21**	**59.55**	**53.55**	**57.86**	**55.05**	**55.21**
		Total	**65.97**	**63.25**	**59.03**	**62.45**	**71.43**	**70.19**	**57.72**	**51.18**	**55.66**	**53.45**	**52.08**

TABLE 3

MORTALITY EXPERIENCE OF U.T./N.C.T. OF DELHI - 1984 TO 1994
DISEASE WISE NUMBER OF DEATHS AS PERCENTAGE OF TOTAL NUMBER OF DEATHS IN RESPECTIVE YEARS

DISEASES	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Cholera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Typhoid and Para Typhoid	0.13	0.06	0.02	0.02	0.03	0.04	0.09	0.31	0.36	0.11	0.16
Food Poisoning	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01
Dysentery, diarrhoea and Gastro Enteritis	1.49	1.60	1.81	2.22	2.36	2.47	1.71	1.24	1.18	1.18	1.41
Tuberculosis	4.64	4.23	4.71	4.39	4.51	4.14	5.01	5.86	5.83	6.10	6.07
Leprosy	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.06	0.01
Diptheria	0.10	0.10	0.15	0.14	0.21	0.20	0.21	0.11	0.14	0.10	0.08
Whooping Cough	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.01
Tetanus	0.31	0.39	0.33	0.87	0.45	0.45	0.51	0.27	0.20	0.20	0.17
Poliomyelitis	0.02	0.06	0.04	0.07	0.11	0.06	0.14	0.10	0.05	0.08	0.11
Measles	0.16	0.29	0.25	0.25	0.42	0.32	0.28	0.21	0.17	0.08	0.14
Rabies	0.02	0.03	0.05	0.04	0.05	0.05	0.04	0.06	0.04	0.05	0.06
Malaria	0.13	0.15	0.08	0.04	0.11	0.08	0.17	0.22	0.19	0.14	0.16
Cancer	0.48	0.45	0.55	1.18	0.47	1.09	1.87	2.39	2.03	2.38	2.77
Diabetes Mellitus	0.58	0.63	0.65	0.83	0.81	0.69	1.03	1.17	1.19	1.16	1.32
Anaemias	0.69	0.54	0.38	1.26	0.58	0.38	1.05	1.65	1.22	1.62	1.52
Meningitis	0.72	1.46	1.21	1.86	1.22	1.23	1.43	1.12	1.37	1.46	1.32
Heart Diseases and Heart Attack	3.87	6.94	10.34	4.41	3.23	3.84	8.12	9.41	8.25	8.21	8.35
Pneumonia	1.07	1.06	0.91	1.12	1.30	1.49	1.86	2.71	2.21	2.13	2.20
Influenza	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Bronchitis and Asthma	1.33	1.17	1.02	1.57	0.96	0.65	1.77	1.74	1.57	1.77	2.03
Jaundice	0.04	0.03	0.06	0.49	1.00	1.33	0.89	1.08	0.47	0.75	0.90
Chronic Liver Disease and Cirrhosis	0.64	0.75	0.92	1.33	0.47	0.33	0.67	0.63	0.73	1.32	1.36
Ulcer of Stomach and Duodenum	0.04	0.08	0.05	0.02	0.00	0.00	0.00	0.03	0.03	0.02	0.04

DISEASES	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Appendicitis	0.21	0.24	0.23	0.00	0.00	0.00	0.00	0.01	0.04	0.01	0.01
Syphillis and Other Diseases of Genitourinary System	0.13	0.48	1.16	0.19	0.40	0.39	0.20	0.14	0.11	0.18	0.60
Abortion	0.02	0.03	0.02	0.02	0.01	0.00	0.02	0.03	0.01	0.02	0.02
Complications Related to Pregnancy, Child Birth, Puerperium	0.43	0.36	0.22	0.24	0.17	0.13	0.12	0.19	0.11	0.13	0.13
Certain Conditions Such as Birth Injuries, Slow Growth of Foetus and Premature Originating In Perinatal Period	9.47	8.78	9.57	6.71	5.47	6.00	6.85	8.00	8.53	7.43	5.88
Cerebrovascular (Paralysis)	0.10	0.04	0.30	0.02	0.00	0.00	0.18	0.21	0.14	1.68	1.50
Senility	0.01	0.17	0.19	0.00	0.00	0.00	0.00	0.30	0.06	0.04	0.00
Others not elsewhere classified	65.97	63.25	59.03	62.45	71.43	70.19	57.72	51.18	55.66	53.45	52.08
Bites or stings of venomous animals	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.31	0.52	0.40	0.00
Accidental Burns	1.88	1.80	2.24	2.64	1.90	2.08	2.45	2.73	2.16	2.42	2.50
Falls, Drowning	0.21	0.26	0.28	0.57	0.15	0.00	0.54	0.50	0.47	0.44	0.45
Accidental Poisoning (other than food poisoning)	0.19	0.22	0.17	0.44	0.28	0.30	0.36	0.68	0.20	0.26	0.35
Transport (Traffic) Accident (Involving Railways boards, Aircraft,Motor vehicles, Animal being ridden or driving vehicles).	0.77	0.64	0.81	1.80	0.43	0.25	1.93	1.87	1.50	1.92	1.91
Other Accidents Not Elsewhere Classified	1.94	1.73	1.94	2.41	1.33	1.73	2.31	2.74	2.58	2.02	3.62
Suicide	0.14	0.15	0.10	0.05	0.04	0.03	0.29	0.44	0.36	0.32	0.38
Homicide	2.07	1.78	0.21	0.34	0.07	0.03	0.17	0.33	0.30	0.34	0.36

TABLE 4

MORTALITY EXPERIENCE OF U.T./N.C.T. OF DELHI - 1984 TO 1994
CAUSE SPECIFIC DEATH RATES - DELHI, 1984 - 1994

DISEASES	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Cholera	0.000	0.000	0.013	0.012	0.000	0.011	0.000	0.031	0.000	0.000	0.000
Typhoid and Para Typhoid	0.908	0.402	0.141	0.099	0.213	0.250	0.589	1.981	2.239	0.675	1.011
Food Poisoning	0.000	0.000	0.000	0.025	0.047	0.023	0.011	0.010	0.030	0.049	0.038
Dysentery, diarrhoea and Gastro Enteritis	10.473	10.726	11.471	14.580	15.991	16.532	10.675	7. 8 74	7.375	7.395	9.105
Tuberculosis	32.618	28.402	29.852	28.814	30.610	27.637	31.338	37.208	36.561	38.227	39.093
Leprosy	0.014	0.067	0.013	0.037	0.035	0.045	0.044	0.084	0.071	0.391	0.085
Diptheria	0.712	0.696	0.938	0.937	1.443	1.317	1.287	0.723	0.851	0.636	0.491
Whooping Cough	0.000	0.054	0.039	0.062	0.047	0.159	0.044	0.010	0.071	0.049	0.066
Tetanus	2.178	2.625	2.068	5.719	3.040	3.009	3.206	1.698	1.236	1.272	1.105
Poliomyelitis	0.154	0.429	0.283	0.444	0.721	0.386	0.861	0.640	0.344	0.509	0.689
Measles	1.103	1.968	1.554	1.639	2.862	2.123	1.745	1.363	1.043	0.528	0.916
Rabies	0.140	0.214	0.308	0.234	0.319	0.329	0.229	0.356	0.233	0.313	0.406
Malaria	0.936	1.004	0.527	0.271	0.745	0.568	1.036	1.384	1.216	0.880	1.058
Cancer	3.393	3.013	3.481	7.752	3.170	7.312	11.733	15.212	12.704	14.946	17.860
Diabetes Mellitus	4.063	4.232	4.110	5.435	5.512	4.599	6.477	7.454	7.436	7.268	8.482
Anaemias	4.859	3.656	2.415	8.270	3.915	2.521	6.575	10.474	7.638	10.153	9.757
Meningitis	5.069	9.802	7.668	12.238	8.256	8.221	8.974	7.129	8.621	9.126	8.500
Heart Diseases and Heart Attack	27.215	46.534	65.600	28.938	21.905	25.684	50.802	59.770	51.727	51.501	53.760
Pneumonia	7.540	7.084	5.767	7.333	8.847	9.935	11.613	17.236	13.889	13.342	14.186
Influenza	0.000	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.020	0.020	0.057
Bronchitis and Asthma	9.369	7.834	6.487	10.316	6.493	4.326	11.100	11.082	9.847	11.112	13.043
Jaundice	0.265	0.174	0.385	3.204	6.789	8.857	5.550	6.888	2.958	4.676	5.809
Chronic Liver Disease and Cirrhosis	4.482	5.048	5.844	8.713	3.182	2.214	4.198	4.015	4.609	8.275	8.727
Ulcer of Stomach and Duodenum	0.265	0.536	0.321	0.111	0.024	0.000	0.022	0.210	0.203	0.127	0.274

DISEASES	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Appendicitis	1.480	1.634	1.464	0.025	0.000	0.000	0.022	0.042	0.274	0.068	0.066
Syphillis and Other Diseases of Genitourinary System	0.950	3.254	7.373	1.245	2.697	2.612	1.254	0.902	0.669	1.135	3.872
Abortion	0.168	0.214	0.154	0.099	0.035	0.011	0.120	0.168	0.091	0.108	0.142
Complications Related to Pregnancy, Child Birth, Puerperium	3.058	2.384	1.413	1.578	1.183	0.897	0.763	1.185	0.709	0.812	0.822
Certain Conditions Such as Birth Injuries, Slow Growth of Foetus and Premature Originating In Perinatal Period	66.647	58.934	60.680	44.072	37.127	40.082	42.864	50.816	53.530	46.561	37.884
Cerebrovascular (Paralysis)	0.670	0.254	1.901	0.111	0.024	0.000	1.134	1.331	0.902	10.535	9.643
Senility	0.042	1.152	1.195	0.025	0.012	0.023	0.011	1.887	0.375	0.264	0.019
Others not elsewhere classified	464.100	424.414	374.395	409.970	484.488	468.928	361.273	325.184	349.140	335.179	335.323
Bites or stings of venomous animals	0.042	0.054	0.051	0.000	0.000	0.000	0.000	1.981	3.252	2.504	0.000
Accidental Burns	13.195	12.065	14.181	17.353	12.880	13.910	15.342	17.362	13.545	15.181	16.066
Falls, Drowning	1.466	1.768	1.747	3.722	1.029	0.000	3.358	3.187	2.928	2.778	2.928
Accidental Poisoning (other than food poisoning)	1.340	1.500	1.053	2.921	1.904	2.032	2.279	4.309	1.226	1.634	2.229
Transport (Traffic) Accident (Involving Railways boards, Aircraft,Motor vehicles, Animal being ridden or driving vehicles).	5.432	4.312	5.112	11.794	2.933	1.658	12.071	11.868	9.421	12.071	12.297
Other Accidents Not Elsewhere Classified	13.614	11.610	12.306	15.812	9.036	11.548	14.448	17.424	16.168	12.648	23.310
Suicide	0.991	0.978	0.604	0.345	0.260	0.170	1.799	2.789	2.269	1.986	2.427
Homicide	14.578	11.958	1.323	2.218	0.461	0.182	1.080	2.065	1.884	2.132	2.295
Crude Death Rate (per 1,00,000 of population)	703.530	670.983	634.250	656.470	678.238	668.113	625.925	635.333	627.306	627.064	643.841

Note: **Cause Specific Death Rate** is calculated as the ratio of 'number of deaths due to a specific cause in a year' to 'the estimated mid year population of that year' multiplied by 1,00,000; the **Crude Death Rate** is obtained as the ratio of 'total number of deaths in a year ' to 'the estimated mid year population of that year' multiplied by 1,00,000.

2 MORBIDITY AND MORTALITY EXPERIENCE OF DELHI OVER THE YEARS 1993 TO 1995

In this section we attempt to analyse data on morbidity and mortality in Delhi over the years 1993 to 1995 as obtained from hospitals under the Directorate of Health Services (D.H.S.). It is true that the coverage is partial as it does not include data from various types of clinics, nursing homes, private hospitals etc. in Delhi. However, the hospitals under D.H.S. are more easily accessible to general public than private hospitals, nursing homes etc. as the latter are more expensive and beyond the means of masses. The D.H.S hospitals' data alone are fairly substantial and should reflect the health scenario in Delhi sufficiently accurately.

The Table 1 gives the 'number of cases' (including in–patients and out–patients) and 'number of deaths' due to various diseases over the years 1993, 1994 and 1995; and the Table 2 provides ranking of various diseases by number of cases and number of deaths. The rank 1 indicates the highest number of cases/deaths.

We observe that there is very large number of cases of 'intestinal infectious diseases' in each of the years 1993, 1994 and 1995. They rank 3rd highest in 1993 and 1995 and 2nd highest in 1994. The number of deaths due to this cause ranks 9th in all these years.

The number of cases of respiratory diseases at serial number 31 and 32 also rank fairly high among all diseases. The number of cases of 'upper respiratory tract' rank 4th in 1993, 3rd in 1994 and 5th in 1995; where as those of 'other diseases of respiratory system' rank the 2nd highest in 1993 and 1995 and Ist in 1994. The number of deaths due to the latter cause rank 5th, 2nd and 6th in 1993, 1994 and 1995, respectively.

The number of cases of 'diseases of skin and subcutaneous tissue' at serial number 42 rank 6th highest in 1993 and 1994 and Ist in 1995; although number of deaths due to this cause have rather low rank of 25th, 39th and 38th in 1993, 1994 and 1995, respectively.

The number of deaths due to 'certain conditions originating in perinatal period' at serial number 45 have high ranks of 4th, Ist and Ist in 1993, 1994 and 1995, respectively, although the number of cases of this cause have low ranks of 35th, 26th and 11th,

respectively, in these years.

'Diseases of blood and blood forming organs' at serial number 20 have rather high ranks of 8th, 8th and 4th in 1993, 1994 and 1995, respectively, although number of deaths due to this cause rank low at 22nd and 24th in 1994 and 1995. Number of deaths due to this cause ranked Ist in 1993.

TABLE 1

CASES OF MORBIDITY AND MORTALITY DUE TO DIFFERENT DISEASES IN DELHI (HOSPITALS UNDER DIRECTORATE OF HEALTH SERVICES)

.	Category	Code No.	1993		1994		1995	
			Cases	Deaths	Cases	Deaths	Cases	Deaths
1	Intestinal infectious diseases	001–009	135618	508	132711	335	62490	423
2	Tuberculosis	010–018	17370	510	22430	440	12242	518
3	Other Bacterial diseases	020–041	2071	399	2068	455	1988	459
4	Viral diseases	045–079	21283	139	15293	223	21113	181
5	Ricektisisosis and other Arthropod Borne Diseases	080–088	12025	24	11306	99	6273	108
6	Venereal Diseases	090–099	494	0	1020	0	787	0
7	Other Infectious and Parasitic Diseases and their Late effects	100–139	9415	7	7750	5	13803	12
8	Malignant Neoplasm of Lip Oral Cavity and Pharynx	140–149	128	13	138	16	588	8
9	Malignant Neoplasm of Digestive Organs and Peritoneum	150–159	689	85	645	65	629	81
10	Malignant Neoplasm of Respiratory and Intrathoracis organs	160–165	389	27	209	16	260	24
11	Malignant Neoplasm of Bone, Connective Tissue, Skin and Breast	170–175	612	12	499	8	504	18
12	Malignant Neoplasm of Genito Urinary Organs	179–189	807	36	487	21	537	25
13	Malignant Neoplasm of other and Unspecified Sites	190–199	370	55	148	36	344	52
14	Malignant Neoplasm of Dymphatic and Haemopoietic Tissue	200–208	353	53	390	40	401	41
15	Benign Neoplasm	210–229	951	20	733	7	1028	15
16	Carcinoma in Situ	230–234	0	0	23	0	47	0
17	Other and Unspecified Neoplasm	235–239	338	3	883	22	553	22
18	Endocrine and Metabolic Diseases Immunity Disorders	240–259	8661	1215	6372	139	3307	119
19	Nutritional Deficiencies	260–269	8203	88	8645	77	9322	112
20	Diseases of Blood and Blood Forming organs	280–289	43760	2451	48689	109	59761	99
21	Mental Disorders	290–319	48148	1482	8945	19	7900	21

	Category	Code No.	1993		1994		1995	
			Cases	Deaths	Cases	Deaths	Cases	Deaths
22	Diseases of the Nervous System	320–359	8399	305	8038	448	5837	508
23	Disorders of the Eye and Adnexa	360–379	39226	2	83075	3	55927	3
24	Disease of the Car and Mastoid Process	380–389	32399	4	15578	5	20441	3
25	Rheumatic Fever and Rheumatic Heart Disease	390–398	3016	234	4648	228	7753	265
26	Hypertensive Diseases	401–405	23324	145	49048	103	23095	113
27	Ischaemic Heart Diseases	410–414	3575	302	37828	309	23763	343
28	Diseases of Pulmonary Circulation and other forms of Heart Disease	415–429	1591	161	4795	149	3733	495
29	Carebrovascular Disease	430–438	18954	412	2863	311	2620	419
30	Other Diseases of the Circulatory System	440–459	4992	47	8736	14	5076	19
31	Diseases of the Upper Respiratory Tract	460–465	110341	11	123774	12	57019	1
32	Other diseases of the Respiratory System	466–519	160073	625	175096	657	63950	506
33	Diseases of the Oral Cavity, Salivary Glands and Jaws	520–529	27245	0	40685	3	19613	3
34	Diseases of the Other Parts of Digestive System	530–579	27934	580	16861	559	1585	9
35	Diseases of Urinary System	580–599	10357	214	18547	197	6824	306
36	Diseases of the Male Genital Organs	600–608	13774	3	4099	7	4640	3
37	Diseases of Female Genital organs	610–629	22274	17	35968	8	32432	6
38	Abortion	630–639	76280	31	9446	8	7933	5
39	Direct Obstetric causes	640–646 (651–676)	267510	32	23588	28	10763	48
40	Indirect Obstetric Causes	647–648	220	11	1566	1	269	14
41	Normal Delivery	650	12509	1	12571	1	12663	5
42	Diseases of Skin and Subcutaneous Tissue	680–709	66711	116	51841	17	67128	22
43	Diseases of the Musculoskeletal system and Connective Tissue	710–739	11602	9	16618	24	7109	10
44	Congenital Anaemies	740–759	2764	161	2000	143	2320	216

	Category	Code No.	1993		1994		1995	
			Cases	Deaths	Cases	Deaths	Cases	Deaths
45	Certain Conditions Originating in the Perinatal period	760–779	4588	831	3033	845	22503	685
46	Signs, Symptoms and Ill defined conditions	780–799	41139	241	72463	242	50696	216
47	Fractures	800–829	11322	102	13150	53	16021	46
48	Dislocations, Sprains and Strains	830–848	14592	6	8259	3	8959	277
49	Intracranial and Internal Injuries including nerves	850–869 (950–957)	9655	428	7153	293	3600	17
50	Open Wounds and Injury to Blood Vessels	870–904	1561	28	2770	4	3638	2
21	Effects of Foreign Body Entering Through Orifice	930–939	541	4	286	2	408	2
52	Burns	940–949	1763	557	2550	517	1903	52
53	Poisonings and Toxic Effects	960–989	738	130	632	54	701	2
54	Complications of Medical and Surgical Care	996–999	551	11	177	6	181	28
55	Other injuries, early complications of trauma	910–929, 958–959, 990–995	5091	13	2060	18	3376	0
56	Late effects of injuries of Toxic effects and of their external causes	905–909	3	3	7275	0	223	113
57	Transport Accidents	E800–E848	6266	181	8851	113	10676	11
58	Accidental Poisoning	E850–869	307	51	470	10	151	8
59	Misadventure during medical care abnormal reactions, late complications	E870–E879	5	0	6	1	71	1
60	Accidental falls	E880–E888	500	22	792	40	6016	18
61	Accidents caused by fire and flames	E890–E899	647	177	986	365	1373	13
62	Other Accidents including late effects	E900–E929	681	97	680	111	361	41
63	Drugs, medicaments causing adverse effects in therapautic use	E930–E949	123	3	44	0	151	1
64	Suicide and self inflicted injury	E950–E959	449	77	545	86	3514	70
65	Homicide and injury purposely inflected by other persons	E960–E969	336	26	1160	31	1530	26
66	Other Violence	E970–E999	336	3	410	7	5163	33
	Total		1557413	15343	2103364	13968	1258074	12920

TABLE 2

CASES OF MORBIDITY AND MORTALITY DUE TO DIFFERENT DISEASES IN DELHI (RANKING) (HOSPITALS UNDER DIRECTORATE OF HEALTH SERVICES)

	Category	Code No.	1993		1994		1995	
			Cases	Deaths	Cases	Deaths	Cases	Deaths
1	Intestinal infectious diseases	001–009	3	9	2	9	3	9
2	Tuberculosis	010–018	18	8	13	7	19	4
3	Other Bacterial diseases	020–041	39	12	40	5	44	8
4	Viral diseases	045–079	16	23	18	15	12	17
5	Ricektisisosis and other Arthropod Borne Diseases	080–088	22	41	21	24	29	22
6	Venereal Diseases	090–099	53	67	45	52	49	67
7	Other Infectious and Parasitic Diseases and their Late effects	100–139	28	53	29	47	16	48
8	Malignant Neoplasm of Lip Oral Cavity and Pharynx	140–149	63	46	63	40	52	52
9	Malignant Neoplasm of Digestive Organs and Peritoneum	150–159	46	29	51	27	51	25
10	Malignant Neoplasm of Respiratory and Intrathoracis organs	160–165	55	39	60	40	61	37
11	Malignant Neoplasm of Bone, Connective Tissue, Skin and Breast	170–175	49	48	54	44	55	43
12	Malignant Neoplasm of Genito Urinary Organs	179–189	44	35	55	36	54	36
13	Malignant Neoplasm of other and Unspecified Sites	190–199	56	31	62	31	59	28
14	Malignant Neoplasm of Dymphatic and Haemopoitic Tissue	200–208	57	32	58	30	57	31
15	Benign Neoplasm	210–229	43	44	49	45	48	45
16	Carcinoma in Situ	230–234	67	64	65	52	67	65
17	Other and Unspecified Neoplasm	235–239	58	60	47	35	53	39
18	Endocrine and Metabolic Diseases Immunity Disorders	240–259	29	3	32	19	41	18
19	Nutritional Deficiencies	260–269	31	28	26	26	22	21
20	Diseases of Blood and Blood Forming organs	280–289	8	1	8	22	4	24
21	Mental Disorders	290–319	7	2	23	37	25	40
22	Diseases of the Nervous System	320–359	30	13	28	6	32	5

	Category	Code No.	1993		1994		1995	
			Cases	Deaths	Cases	Deaths	Cases	Deaths
23	Disorders of the Eye and Adnexa	360–379	10	62	4	49	6	59
24	Disease of the Car and Mastoid Process	380–389	11	55	17	47	13	56
25	Rheumatic Fever and Rheumatic Heart Disease	390–398	37	16	34	14	26	14
26	Hypertensive Diseases	401–405	14	22	7	23	10	19
27	Ischaemic Heart Diseases	410–414	36	14	10	11	9	11
28	Diseases of Pulmonary Circulation and other forms of Heart Disease	415–429	41	21	33	17	36	7
29	Carebrovascular Disease	430–438	17	11	37	10	42	10
30	Other Diseases of the Circulatory System	440–459	34	34	25	41	34	41
31	Diseases of the Upper Respiratory Tract	460–465	4	50	3	42	5	62
32	Other diseases of the Respiratory System	466–519	2	5	1	2	2	6
33	Diseases of the Oral Cavity, Salivary Glands and Jaws	520–529	13	65	9	49	14	58
34	Diseases of the Other Parts of Digestive System	530–579	12	6	15	3	17	2
35	Diseases of Urinary System	580–599	26	17	14	16	28	12
36	Diseases of the Male Genital Organs	600–608	20	57	35	45	35	57
37	Diseases of Female Genital organs	610–629	15	45	11	44	8	53
38	Abortion	630–639	5	37	22	44	24	54
39	Direct Obstetric causes	640–646 (651–676)	1	36	12	33	20	29
40	Indirect Obstetric Causes	647–648	62	51	43	51	60	46
41	Normal Delivery	650	21	63	20	51	18	55
42	Diseases of Skin and Subcutaneous Tissue	680–709	6	25	6	39	1	38
43	Diseases of the Musculoskeletal system and Connective Tissue	710–739	24	52	16	34	27	50
44	Congenital Anaemies	740–759	38	20	42	18	43	15
45	Certain Conditions Originating in the Perinatal period	760–779	35	4	36	1	11	1
46	Signs, Symptoms and Ill defined conditions	780–799	9	15	5	13	7	16

	Category	Code No.	1993		1994		1995	
			Cases	Deaths	Cases	Deaths	Cases	Deaths
47	Fractures	800–829	25	26	19	29	15	30
48	Dislocations, Sprains and Strains	830–848	19	54	27	49	23	13
49	Intracranial and Internal Injuries including nerves	850–869 (950–957)	27	10	31	12	38	44
50	Open Wounds and Injury to Blood Vessels	870–904	42	38	38	48	37	60
21	Effects of Foreign Body Entering Through Orifice	930–939	51	56	59	50	56	3
52	Burns	940–949	40	7	39	4	45	27
53	Poisonings and Toxic Effects	960–989	45	24	52	28	50	61
54	Complications of Medical and Surgical Care	996–999	50	49	61	46	63	34
55	Other injuries, early complications of trauma	910–929, 958–959, 990–995	33	47	41	38	40	66
56	Late effects of injuries of Toxic effects and of their external causes	905–909	66	59	30	52	62	20
57	Transport Accidents	E800–E848	32	18	24	20	21	49
58	Accidental Poisoning	E850–869	61	33	56	43	64	51
59	Misadventure during medical care abnormal reactions, late complications	E870–E879	65	66	66	50	66	64
60	Accidental falls	E880–E888	52	42	48	30	31	42
61	Accidents caused by fire and flames	E890–E899	48	19	46	8	47	47
62	Other Accidents including late effects	E900–E929	47	27	50	21	58	32
63	Drugs, medicaments causing adverse effects in therapautic use	E930–E949	64	58	64	52	65	63
64	Suicide and self inflicted injury	E950–E959	54	30	53	25	39	26
65	Homicide and injury purposely inflected by other persons	E960–E969	59	40	44	32	46	35
66	Other Violence	E970–E999	60	61	57	45	33	33

3 ESTIMATE OF THE PROBABILITY OF DEATH BY A SPECIFIC CAUSE

Using the data in the Table 1 we may calculate the ratio

$$R = \frac{\text{total number of deaths by a specific cause during 1993 - 1995}}{\text{total number of cases of that cause during 1993 - 1995}}$$

which may be interpreted as the 'relative frequency' of occurrence of death by a specific disease. This relative frequency may also be used as the **estimate of probability** of death by that specific cause.

We observe that the 'bacterial diseases' at serial number 3 cause 21.43% of all deaths, where as deaths due to 'burns' cause 18.11% of all deaths and those due to 'accidents caused by fire and flames' cause 18.46% of all deaths. 'Malignant neoplasms of other and unspecified sites' at serial number 13 cause 16.59%; where as 'malignant neoplasms of digestive organs and peritoneum' cause 11.77% and 'malignant neoplasm of dymphatic and haemopoietic tissue' cause 11.71% of deaths.

TABLE 1

MORBIDITY AND MORTALITY EXPERIENCE OF U.T./N.C.T. OF DELHI– 1993 TO 1994 RELATIVE FREQUENCY OF DEATHS BY VARIOUS CAUSES (HOSPITALS UNDER DIRECTORATE OF HEALTH SERVICES)

	Category	Code No.	Cases	Deaths	(No. of Deaths ÷ No. of Cases) × 100 (%)
			(total of 1993–1995)		
1	Intestinal infectious diseases	001–009	330819	1266	0.38
2	Tuberculosis	010–018	52042	1468	2.82
3	Other Bacterial diseases	020–041	6127	1313	21.43
4	Viral diseases	045–079	57689	543	0.94
5	Ricektisisosis and other Arthropod Borne Diseases	080–088	29604	231	0.78
6	Venereal Diseases	090–099	2301	0	0
7	Other Infectious and Parasitic Diseases and their Late effects	100–139	30968	24	0.08
8	Malignant Neoplasm of Lip Oral Cavity and Pharynx	140–149	854	37	4.33
9	Malignant Neoplasm of Digestive Organs and Peritoneum	150-159	1963	231	11.77
10	Malignant Neoplasm of Respiratory and Intrathoracis organs	160–165	858	67	7.81
11	Malignant Neoplasm of Bone, Connective Tissue, Skin and Breast	170–175	1615	38	2.35
12	Malignant Neoplasm of Genito Urinary Organs	179–189	1831	82	4.48
13	Malignant Neoplasm of other and Unspecified Sites	190–199	862	143	16.59
14	Malignant Neoplasm of Dymphatic and Haemopoitic Tissue	200–208	1144	134	11.71
15	Benign Neoplasm	210–229	2712	42	1.55
16	Carcinoma in Situ	230–234	70	0	0
17	Other and Unspecified Neoplasm	235–239	1774	47	2.65
18	Endocrine and Metabolic Diseases Immunity Disorders	240–259	18340	1473	8.03
19	Nutritional Deficiencies	260–269	26170	277	1.06
20	Diseases of Blood and Blood Forming organs	280–289	152210	2659	1.75
21	Mental Disorders	290–319	64993	1522	2.34

	Category	Code No.	Cases	Deaths	(No. of Deaths ÷ No. of Cases) × 100 (%)
			(total of 1993–1995)		
22	Diseases of the Nervous System	320–359	22274	1261	5.66
23	Disorders of the Eye and Adnexa	360–379	178228	8	0.00
24	Disease of the Car and Mastoid Process	380–389	68418	12	0.02
25	Rheumatic Fever and Rheumatic Heart Disease	390–398	15417	727	4.72
26	Hypertensive Diseases	401–405	95467	361	0.38
27	Ischaemic Heart Diseases	410–414	65166	954	1.46
28	Diseases of Pulmonary Circulation and other forms of Heart Disease	415–429	10119	805	7.96
29	Cerebrovascular Disease	430–438	24437	1142	4.67
30	Other Diseases of the Circulatory System	440–459	18804	80	0.43
31	Diseases of the Upper Respiratory Tract	460–465	291134	24	0.01
32	Other diseases of the Respiratory System	466–519	399119	1788	0.45
33	Diseases of the Oral Cavity, Salivary Glands and Jaws	520–529	87543	6	0.01
34	Diseases of the Other Parts of Digestive System	530–579	46380	1148	2.48
35	Diseases of Urinary System	580–599	35728	717	2.01
36	Diseases of the Male Genital Organs	600–608	22513	13	0.06
37	Diseases of Female Genital organs	610–629	90674	31	0.03
38	Abortion	630–639	93659	44	0.05
39	Direct Obstetric causes	640–646 (651–676)	301861	108	0.04
40	Indirect Obstetric Causes	647–648	2055	26	1.27
41	Normal Delivery	650	37743	7	0.02
42	Diseases of Skin and Subcutaneous Tissue	680–709	185680	155	0.08
43	Diseases of the Musculoskeletal system and Connective Tissue	710–739	35329	43	0.12
44	Congenital Anaemies	740–759	7084	520	7.34
45	Certain Conditions Originating in the Perinatal period	760–779	30124	2361	7.84

	Category	Code No.	Cases	Deaths	(No. of Deaths ÷ No. of Cases) × 100 (%)
			(total of 1993–1995)		
46	Signs, Symptoms and Ill defined conditions	780–799	164298	699	0.43
47	Fractures	800–829	40493	201	0.50
48	Dislocations, Sprains and Strains	830–848	31810	286	0.90
49	Intracranial and Internal Injuries including nerves	850–869 (950–957)	20408	738	3.62
50	Open Wounds and Injury to Blood Vessels	870–904	7969	34	0.43
51	Effects of Foreign Body Entering Through Orifice	930–939	1235	8	0.65
52	Burns	940–949	6216	1126	18.11
53	Poisonings and Toxic Effects	960–989	2071	186	8.98
54	Complications of Medical and Surgical Care	996–999	909	45	4.95
55	Other injuries, early complications of trauma	910–929, 958–959, 990–995	10527	31	0.29
56	Late effects of injuries of Toxic effects and of their external causes	905–909	7501	116	1.55
57	Transport Accidents	E800–E848	25793	305	1.18
58	Accidental Poisoning	E850–869	928	69	7.44
59	Misadventure during medical care abnormal reactions, late complications	E870–E879	82	2	2.44
60	Accidental falls	E880–E888	7308	80	1.09
61	Accidents caused by fire and flames	E890–E899	3006	555	18.46
62	Other Accidents including late effects	E900–E929	1722	249	14.46
63	Drugs, medicaments causing adverse effects in therapautic use	E930–E949	318	4	1.26
64	Suicide and self inflicted injury	E950–E959	4508	233	5.17
65	Homicide and injury purposely inflected by other persons	E960–E969	3026	83	2.74
66	Other Violence	E970–E999	5909	43	0.73

CHAPTER IV

SOCIO ECONOMIC PROFILE OF THE POPULATION OF DELHI, SAMPLE DESIGN AND THE QUESTIONNAIRE

1 GROWTH OF THE POPULATION OF DELHI AND EMERGENCE OF SLUMS

The population of Delhi consists of both the slum and non–slum households.

Where as, there is no exact definition of a slum, it is true that they share some common characteristics, specially with regard to their unhygienic conditions, prevalence of infectious and communicable diseases, kutcha houses (or, hutments), overcrowding and poverty, lack of civic amenities (like drinking water, electricity, sanitation etc.). The slums may differ significantly according to their age, size, nature of inhabitants, heterogeneity of housing standards and relative deprivation of the dwellers. We should examine the conditions under which they have emerged in Delhi.

Historically, the walled city of Delhi (called old Delhi) consisting of localities like Farash Khana, Hauz Qazi, Jama Masjid, Darya Ganj, Chandni Chowk, etc. was built during the Moghul period, to house about fifty to sixty thousand people. Spacious havelis, kutchas and katras were built with narrow lanes and streets to suit the climatic needs of people at that time.

In recent years, the walled city has become the nerve centre of business activities and caters to the commercial needs of traders in whole of North India. This has resulted in fast conversion of residential areas into commercial ones. Further, opening of small scale industries in the walled city has led to overcrowding and congestion in the area. The deterioration of buildings in the walled city, overcrowding and congestion, narrow lanes and streets, poor lighting and lack of civic amenities, etc., have led to slum conditions.

Ever since 1951, the economic planning process and rapid developmental activities have led to influx of large number of people in Delhi from various parts of the country and

also from the neighbouring countries. Most of the poor migrants are unskilled workers who work in public and private construction activities or choose jobs such as that of hawkers, rickshaw pullers etc. Their economic conditions do not permit them to afford proper housing. They, generally squat at places of their work or in other open spaces by constructing temporary hutments. In the absence of civic amenities they use open public places for toilet purposes.

Every year about two lakh people migrate to Delhi. Presently about 9.5 lakh persons are living in notified slums, while an estimated 20 lakh people live in jhuggie–jhompri clusters. Approximately, 30,000 shelterless people are forced to sleep on pavements.

The population of Delhi has increased substantially over the last fifty years. In order to provide housing for the increasing population the Delhi Development Authority has been reclaiming land and constructing multi–storeyed buildings to provide flats. The expansion of the city sucked in the colonies of fishermen, herdsmen and villages situated in the periphery. The agricultural land was put to urban land use, where as the inhabited area of the village was left in–tact without infrastructure facilities. Since the housing costs (rents) were rather low in these untouched villages many poor unskilled workers chose to live here. Thus the area got overcrowded and in the absence of adequate municipal facilities led to slum conditions. For example, we have areas of Malickpur, Wazirpur, Mohammedpur, Munirka, Katwaria Sarai etc. In fact, all posh colonies developed by the DDA surround an old village.

Even the non–slum DDA flats have categories like LLIG (low–low income group), LIG (low income group), MIG (middle income group) flats which exhibit unhygienic conditions where residents are prone to many kinds of diseases. However, for the purposes of present study we restrict to slum and non–slum categories only, and examine prevalence of diseases.

2. SAMPLE DESIGN

The aim of this study is to look into the occurence of diseases and their causes, across the population of Delhi.

We sample the population from different socio–economic categories, from non–slum as well as slum areas of urban Delhi.

First of all, for the purposes of sampling the entire city of Delhi has been divided into three concentric (zones) circles, namely

(i) INNER CIRCLE (ZONE)
(ii) MIDDLE CIRCLE (ZONE)
(iii) OUTER CIRCLE (ZONE)

as shown in the map.

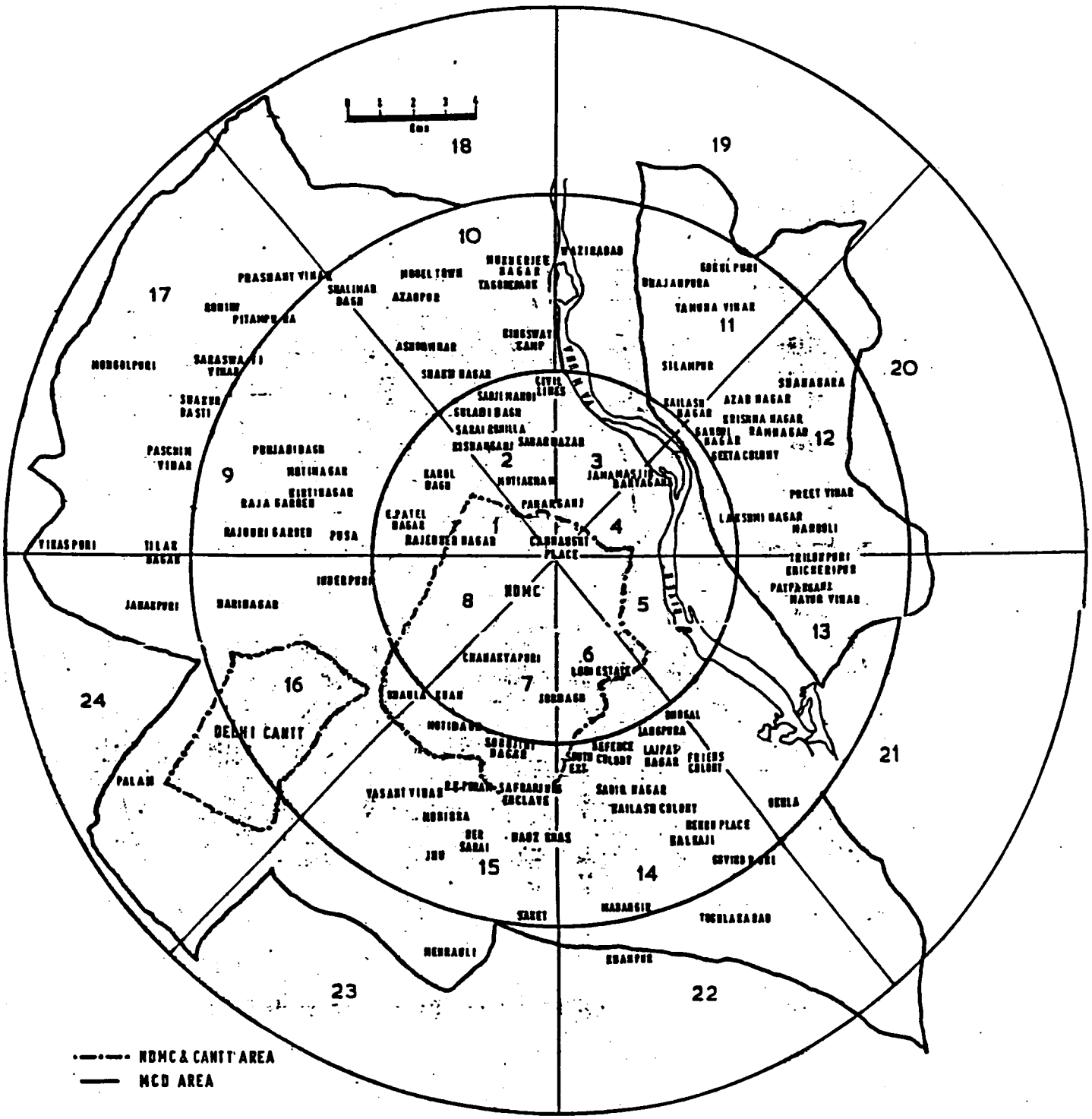
Taking Connaught Place as the central point three concentric circles have been drawn with a radius of 5, 10 and 15 kms, respectively. There after the circles have been subdivided into 8 equal segments subtending an angle of 45^0 at the centre.

Thus, the entire area of the urban Delhi, has been sub–divided, into 24 sub–divisions. One single sub–division may be termed as "cluster". Each cluster consists of several localities of Delhi as listed below in Table 1.

Table 1. Study Area

Cluster 1	Sant Nagar, Devnagar, Bedanpura, Kishan Ganj, Patel Nagar, Ranjit Nagar, Rajendra Nagar, New Rajendra Nagar, Karol Bagh, Regharpura
Cluster 2	Malkaganj, Sabjimandi, Kharia Mohalla, Vivekanandpuri, Sarai Rohilla, Model Basti, Azad Market, Pahari Dhiraj, Sadar Bazar, Aram Nagar, Ram Nagar, Motia Khan, Aram Bagh, Paharganj.
Cluster 3	Budh Vihar, Kashmiri Gate, Ghokhale Market, Mori Gate, Gurudwara Sisganj, Hauzqazi, Jama Masjid, Darya Ganj
Cluster 4	Shakti Sthal, Vijay Ghat, Rajghat, Shantivan, Gandhi Darshan
Cluster 5	Appu Ghar, Supreme Court, Delhi High Court
Cluster 6	Eastern Court, India Gate, Vigyan Bhavan, National Stadium, Kaka Nagar, Indraprastha, Lodi Estate
Cluster 7	Chanakyapuri, North Block, South Block
Cluster 8	Talkatora Stadium, Moghul Garden, Sansad Bhavan, Rastrapati Bhavan, Presidents Estate
Cluster 9	Pusa Institue, S Patel Nagar, Shadi Khanpur, W. Patel Nagar, Baljit Nagar, Prem Nagar, Nehru Nagar, Keshav Puram, Shakti Nagar, W. Punjabibagh, E. Punjabibagh, Onkar Nagar, Bhagwandas Nagar, Shivaji Park, Karampura, Shardapuri Colony, Mansarovar Garden, Subhash Nagar, Nai Basti, Anand Parbat, Thansingh Nagar, Vadhwan Nagar, Subhadra Colony, Indra Lok, Narang Colony, Tri Nagar, Moti Nagar, Sudarshan Park, Bali Nagar, Kirti Nagar, Ramesh Nagar, Rajouri Garden
Cluster 10	Ashok Vihar, Wazirpur, Vivek Nagar, Bharat Nagar, J.J. Colony, Shastri Nagar, Gulabi Bagh, Shakti Nagar, Kamla Nagar, Jawahar Nagar, Rup Nagar, Maurice Nagar, Delhi University, Gandhi Nagar, Dhirpur, Kewal Park, Azadpur, Rana Pratap Bagh, Gujaranwala Colony, Dilkhush Bagh, Malakpura, Guru Teg Bahadur Nagar, Hakikat Nagar, Outram Lines, Indra Vihar, Tagore Park, Harijan Colony, Dhaka Colony, Mukherji Nagar, Nirankari Colony
Cluster 11	Wazirabad, Gopalpur, Nehru Vihar, Timarpur, Majnuka Tila, Old Chandrawal, Sonia Vihar, Dayalpur, Biharipur, Mustabadad, Gokulpuri, Gokulpur, Khajuri Khas, Bhajanpura, Yamuna Vihar, Gaonri, Ghonda, Maujpur, Joyti Nagar, Kartar Nagar, Naya Usmanpur, Brahmapuri, Babarpur, Usmanpur, Kaithwara, Shastri Park
Cluster 12	Shahadra, Nathu Nagar, Sakdarpur, Rothas Nagar, Navin shahadra, Jhilmil colony, Viswas Nagar, Kailash Nagar, Kanti Nagar, Rajgarh Colony, Gandhi Nagar, Azad Nagar, Vigyan Lok, Ram Vihar, Manak Vihar, Jhil Khurenja, Krishna Nagar, Arjun Nagar, Chandra Nagar, Govindpura, Jagatpuri, Krishnakunj, Laxmi Nagar, Shakarpur, Hargovind Enclave, Anand Vihar, Karkar Duma Yojana Vihar
Cluster 13	Patpar Ganj, Mandavli, Ganesh Nagar, Pandav Nagar, Vinod Nagar, Mayur Vihar, Khichripur, Kalyanpuri, Shamspur, Patparganj, Trilokpuri
Cluster 14	Pant Nagar, Jangpura, Jiwan Nagar, Maharani Bagh, Taimur Nagar, Friends Colony, Ishwar Nagar, Sukhdev Vihar, Garhi, Sriniwaspuri, Vinoba Nagar, Pamposh Enclave, Amar Colony, Andrews Ganj, Lajpat Nagar, Kasturba Nagar, Kotla Mubarakpur, Defence Colony, South Extension, Sanwar Nagar, Anand Vihar, Greater Kailash, Sadiq Nagar, East of Kailash, Nehru Place, Videsh Sanchar Enclave
Cluster 15	Hauz Khas, Vasant Vihar, Ber Sarai, Jiya Sarai, Katwaria Sarai, Panchshil, Kalu Sarai, Shahpur Jat, Humayunpur, Munirka, R.K. Puram, Sarojini Nagar, Lakshmi Bai Nagar, Kidwai Nagar, Netaji Nagar, Naorji Nagar, Safdarganj Enclave
Cluster 16	Bapu Dham, Dhaula Kuan, Pratap Chowk, Subroto Park, Khairbar Lines, Asmara Lines, Jharera, Malakand Lines, Indrapuri, Todapur, Das ghara
Cluster 17	Fateh Nagar, Ashok Nagar, Nangli Salab, Krishna Park, Ganesh Nagar, Tilak Nagar, Chawkhand, Tagore Garden, Raghuvir Nagar, Janta Colony, Kheyala, Vishnu Garden, Shakurpur, Sandesh Vihar, Lok Vihar, Pitampura, Rohini, Keshopur, Chandan Garden, Nihal Vihar, Ambika Vihar, Mira Bagh, Sundar Vihar, Paschim Vihar Etx. Jwalaheri, Madipur, Pira Garhi, Mangolpuri, Saraswati Vihar, Shakti Vihar, Sant Nagar, Rani Bagh, Shakur Basti, Mahendra Park
Cluster 18	Badli, Haidarpur, Sahipur, Shalimarbagh, Shingalpur, New Sabji Mandi, Adarsh Nagar, Jahangirpuri, Kamalpur, Jagatpur, Milan Vihar, Sangam Vihar
Cluster 19	Sadatpur, Dayalpur, Prem Nagar, Mustabadad, Gokulpuri, Mit Nagar, Ashok Nagar, Saboli, Jawahar Nagar Colony, Karawal Nagar Shiv Nagar
Cluster 20	Mandauli, Harsh Vihar, Nandnagari, Sunder Nagari, New Simapuri, Tahirpur, Dilshad Garden, Vivek Vihar
Cluster 21	Ghazipur, Gharroli, Kondli, Dalupura, Vasumdhara Enclave, Ashok Nagar
Cluster 22	Okhla, Abdul Fazi Enclave, Zafar Manzu, Madanpur Khadar, Sarita Vihar, Tikhand Tughlakabad, Kalkaji Ext., Kalkaji, Pushp Vihar, Khanpur, Govindpuri, C.R. Park, Shekh Sarai, Madangiri, Ambedkar Nagar, Dakshin Puri, Haresh Nagar, Chirag Delhi, Savitri Nagar
Cluster 23	Begampur, Sarvodaya Enclave, Malviya Nagar, Geetanjali, Press Enclave, Lado Sarai, Saket, Mehrauli, Maidan Garhi, Vasant Kunj, Mahipalpur, Rangpuri
Cluster 24	Salatpur Khadar, Uttam Nagar, Mehram Nagar, Nangal Dairy, Nagal Dewat, Pehladpur, Shekhawati Lines, Shumran Lines, Sanniyal Lines, Sadar Bazar, Palam Enclave, Nasirpur, Sad Nagar, Manglapuri, Sagarpur, Nangal Raya, Lajwanti Garden, Dabri, Bindapur, Anup Nagar, Janakpuri, Pratap Nagar, Hari nagar, Birendara Nagar, Poshangipur, Shiv Nagar, Shankar Garden Raj Nagar, Puran Nagar, Mahavir Enclave

DELHI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NDMC
DELHI CANTT
NDMC & CANTT AREA
MCD AREA

In the inner circle there are three clusters 1,2 and 3 under the Municipal Corporation of Delhi (MCD) while the remaining clusters are under New Delhi Municipal Corporation (NDMC). All the 8 clusters in the middle circle are under MCD. In the outer circle all the clusters are under the charge of MCD but the 24th cluster of the outer circle has one charge under Delhi Cantonment.

Each cluster has slum and non–slum groups of households.

We assume that the households in slum in each cluster are homogeneous with regard to socio–economic and environmental conditions.

According to the sample design, initially we planned to survey one household from the non–slum area and one from the slum area. However, during the survey it turned out that the respondents (specially women) from slum areas were more cooperative than those from non–slum areas. The slum households were more forthright in giving us information required on the questionnaire. (Women respondents were more truthful about the drinking habits of their husbands as the male respondents would try to hide facts). The non–slum households were less cooperative and would reluctantly provide us the required information. Some non–slum households even refused to cooperate. Therefore, we decided to include more slum households in some clusters in the survey than that was originally planned.

According to table No. 1 we were supposed to survey all the areas mentioned cluster–wise. Later we decided to limit our survey to 13 clusters as mentioned in the forthcoming chapter.

3 QUESTIONNAIRE

Schedule No.

Area Code

Household No.

Locality: Slum Non–slum

Address.

Respondent's

Name

Caste

Religion

Family Type (a) Nuclear (b) Joint

How many years have you been residing in Delhi?
Ans.....

Family Profile

S. No.	Relation	Age	Sex	Education contd.	Education complete	Marital Status	Age at marriage
1. Respondent	Self						

Work Status

S. No.	Earning (E)/Non–earning (NE)	Nature of Job	Income
1. Respondent			

Details of Housing Infra structure and facilities

Housing Infrastructure

Is your house: i) Own ii) Rented

Does your house have electricity?: i) Yes ii) No.

Is your house i) Kutcha ii) Semi– Pucca iii) Pucca

Floor area of house.....

Number of rooms in the house.....

Do you have a separate kitchen? i) Yes ii) No.

Do you possess any durable goods? i) Yes ii) No

- Radio
- T.V. (colour or black & White)
- Refrigerator
- Electric Fans.
- AC
- Scooter/ Car.

What is your medium of cooking?

- Gas
- Kerosene (stove)
- Chula
- Others

Drinking Water & Sanitation Facilities.

Drinking Water Facility

Source of drinking water...
Source of water for other domestic use...

- Tap
- Public Tap
- Tank
- Pipe Line
- Well
- Hand pump
- Others.

Toilet Facility

Do you have

- Separate toilet
- Common toilet

If common toilet how many people use it?
Ans.....

Do you have

- A separate bathroom
- A common bathroom

If common bathroom how many people use it?
Ans.....

Disposal of house hold waste

Is there a proper drainage system in your locality? 1. Yes 2. No

Are the drains 1. Open 2. Closed

How do you dispose off water?
Use a proper sewer system b) Other methods .....

Do you use garbage bins? 1. Yes 2. No

Does water get accumulated in the compound? 1. Yes 2. No.

Does your neighbourhood get water logged? 1. Yes 2. No.

Nutritional Status

How many full meals do you take on an average in a day?

Does your diet consist of the following (give a tick if it does)
Egg, Milk, butter or ghee, Dal, Fruits, Vegetables, Rice, Wheat (roti, bread)

Personal Habits and Hygiene

Do you consume tobacco? Yes/No

If yes, which of the following do you take?
Cigarettes, bidi, masala (zarda), gutka, Pan, others

What is the approximate number of times you use the above–mentioned item(s)? Ans.....

Do you consume alcohol Yes/no

If yes, what is the source from which you get alcohol 1. Local made 2. Shops.

What is your approximate expenditure on alcohol per day? Ans.....

Do you clean your house and the immediate vicinity Yes/No

How frequently do you clean places where water can get stagnant (e.g. Cooler, tanks, drums)? Ans.....

What kind of method do you use to control mosquitoes and flies?
Insecticides (spray), insect repellent (mat, coil, and ointment), mosquito net, others.

Do you wash your hands before taking food? Yes/ No

Do you clean your fingernails? Yes/ No

How do you store perishable food?
Use refrigerator, other methods.

Do you heat perishable food before consumption ? Yes/ No

Do you eat cut vegetables or fruits from the roadside shops? Yes/ No

Do you purify your drinking water Yes/No.

If yes, what method do you use?

Do you breast feed your child? Yes/No

If no, reason behind it?
Ans.....

Account of illness occurred during the last six months
Category: Minor Disease, Major Disease.

S No.	Relation	Category	Symptom/Nature of illness	Duration of illness

Account of Treatment taken
Part I

S. No.	Relation	Treatment Place(Pvt./Govt)	Department of Treatment	Treatment Cost	Transport Cost

Part II

S No.	Relation	Outcome from Current Treatment	Did you Shift from some other Treatment?	Outcome from Alternative Treatment

Reasons for preferring Pvt. treatment to govt. or vice versa (tick the requisite option)

It is nearer to home

The cost incurred is lower.

The facility provided is better.

If other reason specify.

What is your estimated expenditure on health over last six months?

If you do not go for treatment, give reasons(tick the requisite option)

Medical aid expensive.

These minor complaints do not call for professional assistance.

Can't find time or leave from office.

Will miss a day's wage.

Others.

Physically Handicapped

S No.	Nature of Handicap	Duration	Treatment Method	Treatment Place	Amount	Outcome

Deaths during Last One Year.

S. No.	Relation	Age at Death	Sex	Cause of Death	Type of Medical Attention Provided	Stage at Which Provided

Births

S. No.	Relation	Mother's Age at Delivery	Complications* at birth (mother/child)	Nature of Birth (Caesarian, normal others)

* Includes whether child is premature or normal

If there exists complications.

Treatment Place	Is it Free?	Is it less Expensive	Is the Service Effective	Other Reasons

Number of Deliveries

Sex(child)	Year	Dead/Alive	Delivery Place	Reason	Delivery Expenditure	Delivery By a Trained Personal or Others

Details of Prenatal and Postnatal Care

Public Institute	Private Institute	Parental Home	In-law Home	Maternity Attendance**

** Attendance at birth: 1–2 times /2–3 times/ > 5 times

Immunisation @

Nature	Partially Immunised (No. of doses)	Completely Immunised	Institution (Pvt)	Institution (Govt./Health centre)
BCG				
DTP				
POLIO				
RUBELA				
WHOOPING				
COUGH				
HEPATITIS B				

@ Check the card or ask for it.

CHAPTER V

SOCIO ECONOMIC PROFILE OF SAMPLE HOUSEHOLDS

1 Cluster–Wise Distribution of Households and Persons Surveyed in Slum and Non–slum Areas.

According to the sample design, discussed in the preceding chapter, the whole of the city of Delhi was divided into 24 clusters. Each cluster includes a number of localities, as listed in the Table 1 of that chapter.

The clusters 4, 5, 6, 7 and 8 have been excluded from the survey as they include mostly non–residential areas, like shaktisthal, Raj Ghat, Supreme Court, India Gate, Parliament House, Presidential Estate, etc. Out of the remaining 19 clusters, we selected 13 clusters for the study as they include most densely populated areas.

Our sample includes 291 households from the slum and non–slum areas.

The Table 2, given below, provides the total population of each cluster surveyed, the number of slum and non–slum households and sex–wise distribution of persons included in the sample.

The last column of the Table 2 provides the proportion per 10,000 of population surveyed. Where as, most densely populated clusters have proportions ranging from 3 to 9 per 10,000 of population, the clusters 11, 12, 20 and 22 have smaller proportions of population covered. In fact, these latter clusters are also densely populated and needed larger coverage; but limitations of resources and time forced us to restrict to smaller proportions. We expect that the characteristics of the more intensively surveyed clusters are not significantly different from those not so intensively surveyed. Therefore, the conclusions drawn from the study should hold good for all clusters.

TABLE 2

CLUSTER WISE DISTRIBUTION OF HOUSEHOLDS AND PERSONS INCLUDED IN THE SAMPLE

Cluster	Total Population*	NON–SLUM				SLUM				Proportion per 10,000 of population surveyed
		No. of households surveyed	Males	Females	Total	No. of households surveyed	Males	Females	Total	
1	1,83,719	13	36	40	76	5	12	11	23	5.39
2	2,44,159	15	55	57	112	14	61	46	107	8.97
3	3,57,983	13	54	48	102	9	21	23	44	4.11
9	7,69,984	29	102	92	194	29	82	84	166	4.68
10	4,99,122	23	88	67	155	34	103	99	202	7.15
11	3,81,804	–	–	–	–	1	1	2	3	0.08
12	6,07,439	5	20	14	34	3	12	4	16	0.82
14	3,07,757	15	36	39	75	15	39	31	70	4.71
15	4,29,742	16	40	34	74	15	40	39	79	3.56
16	1,79,613	8	24	14	38	8	24	18	42	4.45
20	2,85,370	1	5	4	9	1	3	4	7	0.56
22	3,37,546	1	3	1	4	2	7	6	13	0.50
23	2,61,134	9	23	22	45	7	17	19	36	3.10
Total	48,45,372	148	486	432	918	143	422	386	808	

* CENSUS OF INDIA, 1991, DELHI DISTRICT CENSUS HANDBOOK, Village and Town Directory, Part XII A and B.

The study covers 291 households of which 148 are in non–slum and 143 in slum areas. The total number of persons covered by the survey is 1726 of whom 918 persons are from non–slum and 808 are from slum households; i.e., 53.19% of persons covered by the survey are from non–slum and 46.81% of persons are from slum households.

The proportion of males included in the sample, from non–slum areas, is 52.94% and females constitute 47.06%. From the slum areas, males included in the sample constitute 52.23% and females 47.77%. Thus, the sex ratio of persons included in the sample works out to be 889 females to 1000 males in non–slum and 915 females to 1000 males in slum areas.

The age and sex distribution of persons included in the sample is given in the Table 3. We observe that a larger proportion of persons below the age of 14 has been included in the sample from slum areas than from non–slum areas. This is because we expect that children from slum areas are more susceptible to diseases than those from non–slum areas and hence they need a more intensive examination. Similarly, a larger proportion of persons above 60 years of age has been included in the sample from non–slum households than from slum households. We expect longevity to be lower in slum households than in non–slum households. This implies that there should be more persons in the population above 60 years in non–slum households than in slum households.

TABLE 3

AGE/SEX DISTRIBUTION OF PERSONS IN THE SAMPLE

Age group	Non–slum Households			Slum Households		
	Males	Females	Total	Males	Females	Total
< 14	131	95	226 (24.62)	157	156	313 (38.74)
15–24	110	86	196 (21.35)	96	67	163 (20.17)
25–44	133	142	275 (29.96)	117	117	234 (28.96)
45–59	65	64	129 (14.05)	36	26	62 (7.67)
60–	47	45	92 (10.02)	16	20	36 (4.46)
Total	486	432	918	422	386	808

The distribution of sample households according to 'family size', in slum and non–slum areas, of different clusters is shown in Table 4.

The households have been classified as:

Small– if the number of members in the family is 1 to 4,

Medium– if the number of members in the family is 5 to 8 and

Large– if the number of members in the family is more than 8.

TABLE 4

DISTRIBUTION OF SAMPLE HOUSEHOLDS IN SLUM AND NON–SLUM AREAS ACCORDING TO THE FAMILY SIZE

Clusters	Family Size						
	1 to 4		5 to 8		More than 8		Total
	Slum	Non–slum	Slum	Non–slum	Slum	Non–slum	
1	2	6	3	5	–	2	18
2	2	5	8	5	4	5	29
3	4	2	3	4	2	7	22
9	10	10	15	13	4	6	58
10	12	7	18	12	4	4	57
11	1	–	–	–	–	–	1
12	2	1	1	3	–	1	8
14	7	8	7	5	1	2	30
15	6	5	6	11	3	–	31
16	2	4	6	4	–	–	16
20	–	–	1	–	–	1	2
22	1	1	–	–	1	–	3
23	2	4	5	5	–	–	16

2 CLUSTERWISE DISTRIBUTION OF PERSONS INCLUDED IN THE SAMPLE ACCORDING TO THEIR LEVEL OF EDUCATION

In general, education plays an important role in determining the health status of people and their quality of life. It helps in raising their economic and social status. A higher level of literacy and level of education of people leads to better personal and civic hygiene, consumption of nutritious food, awareness of immunisation and health care facilities and better management of morbidity. The female literacy and their level of eduction plays a vital role in this process as women are in a better position to take care of nutrition and personal hygiene of the family members.

For the present study we collected primary data on the educational level of persons included in the sample.

We identify the following levels of education:

E_1: Illiterate

E_2: Incomplete Primary Education
(i.e. formal education upto the level of class I, II, III or IV but not passed class V)

E_3: Primary completed
(formal education upto the level of class V, VI, or VII but not passed class VIII).

E_4: Middle School completed
(formal education upto the level of class VIII or IX but not passed class X)

E_5: Junior Secondary School completed
(formal education upto the level of class X or XI but not passed class XII)

E_6: Senior secondary school completed

(i.e. pursuing under graduation)

E_7: Graduation completed

The Table 5 gives the distribution of persons in the sample according to their level of education.

The sample proportions of persons with different level of education provide estimates of proportions in the population of the corresponding clusters.

Although the sample size is rather small in each cluster, sex–wise disaggregation and disaggregation by slum and non–slum areas helps to bring out the differences significantly.

We should note that the clusters 11, 12, 20 and 22 have been sparsely sampled (see Table 2). As such, the sample proportions in these cases may not be satisfactory estimates of proportions in the population. However, given the homogeneity of socioeconomic and environmental conditions in slums and non–slums, the information obtained from these clusters may be useful supplementary information.

Sex–wise distributions of persons in slum and non–slum areas of different clusters by their level of education are given in Tables 6–18.

We postulate that patterns of morbidity in slum and non–slum areas of different clusters depend on the level of education of the people.

TABLE 5

DISTRIBUTION OF PERSONS INCLUDED IN THE SAMPLE ACCORDING TO THEIR LEVEL OF EDUCATION

Slum														
Edu. Level	**Cluster**													
	1	2	3	9	10	11	12	14	15	16	20	22	23	Total
E_1	16	40	24	46	88	1	2	19	17	6	0	2	8	269
E_2	2	26	9	31	46	1	6	22	29	10	1	4	11	198
E_3	2	12	3	35	26	1	3	12	6	14	5	3	4	126
E_4	3	21	1	28	14	0	3	5	15	6	1	3	7	107
E_5	0	3	5	8	16	0	2	6	6	4	0	1	5	56
E_6	0	5	2	15	11	0	0	6	6	1	0	0	1	47
E_7	0	0	0	3	1	0	0	0	0	1	0	0	0	5
Total	23	107	44	166	202	3	16	70	79	42	7	13	36	808
NON–SLUM														
E_1	12	15	22	34	27	0	6	5	9	4	0	2	9	145
E_2	17	19	13	30	29	0	1	13	11	4	0	0	7	144
E_3	7	11	11	21	19	0	5	8	12	2	6	0	4	106
E_4	10	30	12	21	26	0	10	11	5	7	2	0	13	147
E_5	8	8	12	33	15	0	5	10	8	3	0	0	1	103
E_6	20	22	17	45	26	0	5	20	13	11	1	2	8	190
E_7	2	7	15	10	13	0	2	8	16	7	0	0	3	83
Total	76	112	102	194	155	0	34	75	74	38	9	4	45	918

TABLE 6

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
1	E_1	7(58.33)	9(81.82)	16(69.56)	3(8.33)	9(22.5)	12(15.79)
	E_2	1(8.33)	1(9.09)	2(8.70)	5(13.89)	12(30.0)	17(22.37)
	E_3	1(8.33)	1(9.09)	2(8.70)	5(13.89)	2(5.0)	7(9.21)
	E_4	3(25.0)	0	3(13.04)	5(13.89)	5(12.5)	10(13.16)
	E_5	0	0	0	4(11.11)	4(10.0)	8(10.53)
	E_6	0	0	0	13(36.11)	7(17.5)	20(26.31)
	E_7	0	0	0	1(2.78)	1(2.5)	2(2.63)
	Total	12(100)	11(100)	23(100)	36(100)	40(100)	76(100)

(Percentages are shown in brackets)

TABLE 7

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
2	E_1	18(29.51)	22(47.83)	40(37.38)	2(3.64)	13(22.81)	15(13.39)
	E_2	15(24.59)	11(23.91)	26(24.30)	12(21.82)	7(12.28)	19(16.96)
	E_3	7(11.47)	5(10.87)	12(11.22)	6(10.91)	5(8.77)	11(9.82)
	E_4	17(27.87)	4(8.69)	21(19.63)	14(25.45)	16(28.07)	30(26.79)
	E_5	1(1.64)	2(4.35)	3(2.80)	6(10.91)	2(3.51)	8(7.14)
	E_6	3(4.92)	2(4.35)	5(4.67)	11(20.0)	11(19.30)	22(19.64)
	E_7	0	0	0	4(7.27)	3(5.26)	7(6.25)
	Total	61(100)	46(100)	107(100)	55(100)	57(100)	112(100)

(Percentages are shown in brackets)

TABLE 8

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
3	E_1	9(42.86)	15(65.22)	24(54.55)	14(25.93)	8(16.67)	22(21.57)
	E_2	6(28.57)	3(13.04)	9(20.45)	5(9.26)	8(16.67)	13(12.75)
	E_3	3(14.29)	0	3(6.82)	5(9.26)	6(12.5)	11(10.78)
	E_4	0	1(4.35)	1(2.27)	7(12.96)	5(10.42)	12(11.76)
	E_5	3(14.29)	2(8.70)	5(11.36)	7(12.96)	5(10.42)	12(11.76)
	E_6	0	2(8.70)	2(4.55)	8(14.81)	9(18.75)	17(16.67)
	E_7	0	0	0	8(14.81)	7(14.58)	15(14.71)
	Total	21(100)	23(100)	44(100)	54(100)	48(100)	102(100)

(Percentages are shown in brackets)

TABLE 9

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
9	E_1	15(18.29)	31(36.90)	46(27.71)	17(16.67)	17(18.48)	34(17.53)
	E_2	16(19.51)	15(17.86)	31(18.67)	16(15.69)	14(15.22)	30(15.46)
	E_3	19(23.17)	16(19.05)	35(21.08)	4(3.92)	17(18.48)	21(10.82)
	E_4	18(21.95)	10(11.90)	28(16.87)	14(13.72)	7(7.61)	21(10.82)
	E_5	6(7.32)	2(2.38)	8(4.82)	21(20.59)	12(13.04)	33(17.01)
	E_6	6(7.32)	9(10.71)	15(9.04)	27(26.47)	18(19.56)	45(23.20)
	E_7	2(2.44)	1(1.19)	3(1.81)	3(2.94)	7(7.61)	10(5.15)
	Total	82(100)	84(100)	166(100)	102(100)	92(100)	194(100)

(Percentages are shown in brackets)

TABLE 10

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON-SLUM AREAS

Cluster	Education Level	Slum			Non-Slum		
		Male	Female	Total	Male	Female	Total
10	E_1	40(38.83)	48(48.49)	88(43.56)	14(15.91)	13(19.40)	27(17.42)
	E_2	24(23.30)	22(22.22)	46(22.77)	18(20.45)	11(16.42)	29(18.71)
	E_3	14(13.59)	12(12.12)	26(12.87)	11(12.5)	8(11.94)	19(12.26)
	E_4	9(8.74)	5(5.05)	14(6.93)	16(18.18)	10(14.92)	26(16.77)
	E_5	9(8.74)	7(7.07)	16(7.92)	8(9.09)	7(10.45)	15(9.68)
	E_6	6(5.83)	5(5.05)	11(5.45)	15(17.05)	11(16.42)	26(16.77)
	E_7	1(0.97)	0	1(0.50)	6(6.82)	7(10.45)	13(8.39)
	Total	103(100)	99(100)	202(100)	88(100)	67(100)	155(100)

(Percentages are shown in brackets)

TABLE 11

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON-SLUM AREAS

Cluster	Education Level	Slum			Non-Slum		
		Male	Female	Total	Male	Female	Total
11	E_1	0	1(50.0)	1(33.33)	0	0	0
	E_2	0	1(50.0)	1(33.33)	0	0	0
	E_3	1(100)	0	1(33.33)	0	0	0
	E_4	0	0	0	0	0	0
	E_5	0	0	0	0	0	0
	E_6	0	0	0	0	0	0
	E_7	0	0	0	0	0	0
	Total	1(100)	2(100)	3(100)	0	0	0

(Percentages are shown in brackets)

TABLE 12

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
12	E_1	2(16.67)	0	2(12.5)	2(10.0)	4(28.57)	6(17.65)
	E_2	4(33.33)	2(50.0)	6(37.5)	1(5.0)	0	1(2.94)
	E_3	3(25.0)	0	3(18.75)	3(15.0)	2(14.29)	5(14.71)
	E_4	1(8.33)	2(50.0)	3(18.75)	7(35.0)	3(21.43)	10(29.41)
	E_5	2(16.67)	0	2(12.5)	3(15.0)	2(14.29)	5(14.71)
	E_6	0	0	0	2(10.0)	3(21.43)	5(14.71)
	E_7	0	0	0	2(10.0)	0	2(5.88)
	Total	12(100)	4(100)	16(100)	20(100)	14(100)	34(100)

(Percentages are shown in brackets)

TABLE 13

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
14	E_1	13(33.33)	6(19.35)	19(27.14)	2(5.56)	3(7.69)	5(6.67)
	E_2	9(23.08)	13(41.94)	22(31.43)	5(13.89)	8(20.51)	13(17.33)
	E_3	7(17.95)	5(16.13)	12(17.14)	5(13.89)	3(7.69)	8(10.67)
	E_4	4(10.26)	1(3.22)	5(7.15)	4(11.11)	7(17.95)	11(14.67)
	E_5	3(7.69)	3(9.68)	6(8.57)	2(5.56)	8(20.51)	10(13.33)
	E_6	3(7.69)	3(9.68)	6(8.57)	13(36.11)	7(17.95)	20(26.67)
	E_7	0	0	0	5(13.89)	3(7.69)	8(10.67)
	Total	39(100)	31(100)	70(100)	36(100)	39(100)	75(100)

(Percentages are shown in brackets)

TABLE 14

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
15	E_1	6(15.0)	11(28.21)	17(21.53)	4(10.0)	5(14.71)	9(12.16)
	E_2	15(37.5)	14(35.90)	29(36.71)	7(17.5)	4(11.76)	11(14.86)
	E_3	4(10.0)	2(5.13)	6(7.59)	4(10.0)	8(23.53)	12(16.22)
	E_4	7(17.5)	8(20.51)	15(18.99)	5(12.5)	0	5(6.76)
	E_5	3(7.5)	3(7.69)	6(7.59)	6(15.0)	2(5.88)	8(10.81)
	E_6	5(12.5)	1(2.56)	6(7.59)	5(12.5)	8(23.53)	13(17.57)
	E_7	0	0	0	9(22.5)	7(20.59)	16(21.62)
	Total	40(100)	39(100)	79(100)	40(100)	34(100)	74(100)

(Percentages are shown in brackets)

TABLE 15

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
16	E_1	2(8.33)	4(22.22)	6(14.29)	2(8.33)	2(14.29)	4(10.53)
	E_2	4(16.67)	6(33.33)	10(23.81)	2(8.33)	2(14.29)	4(10.53)
	E_3	11(45.83)	3(16.67)	14(33.33)	2(8.33)	0	2(5.26)
	E_4	5(20.83)	1(5.56)	6(14.29)	6(25.0)	1(7.14)	7(18.42)
	E_5	1(4.17)	3(16.67)	4(9.52)	3(12.5)	0	3(7.89)
	E_6	0	1(5.56)	1(2.38)	5(20.84)	6(42.85)	11(28.95)
	E_7	1(4.17)	0	1(2.38)	4(16.67)	3(21.43)	7(18.42)
	Total	24(100)	18(100)	42(100)	24(100)	14(100)	38(100)

(Percentages are shown in brackets)

TABLE 16

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
20	E_1	0	0	0	0	0	0
	E_2	0	1(25.0)	1(14.29)	0	0	0
	E_3	3(100)	2(50.0)	5(71.42)	4(80.0)	2(50.0)	6(66.67)
	E_4	0	1(25.0)	1(14.29)	1(20.0)	1(25.0)	2(22.22)
	E_5	0	0	0	0	0	0
	E_6	0	0	0	0	1(25.0)	1(11.11)
	E_7	0	0	0	0	0	0
	Total	3(100)	4(100)	7(100)	5(100)	4(100)	9(100)

(Percentages are shown in brackets)

TABLE 17

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON–SLUM AREAS

Cluster	Education Level	Slum			Non–Slum		
		Male	Female	Total	Male	Female	Total
22	E_1	1(14.29)	1(16.67)	2(15.38)	2(66.67)	0	2(50.0)
	E_2	3(42.85)	1(16.67)	4(30.77)	0	0	0
	E_3	1(14.29)	2(33.33)	3(23.08)	0	0	0
	E_4	2(28.57)	1(16.67)	3(23.08)	0	0	0
	E_5	0	1(16.67)	1(7.69)	0	0	0
	E_6	0	0	0	1(33.33)	1(100)	2(50.0)
	E_7	0	0	0	0	0	0
	Total	7(100)	6(100)	13(100)	3(100)	1(100)	4(100)

(Percentages are shown in brackets)

TABLE 18

LEVEL OF EDUCATION OF PERSONS INCLUDED IN THE SAMPLE IN SLUM AND NON-SLUM AREAS

Cluster	Education Level	Slum			Non-Slum		
		Male	Female	Total	Male	Female	Total
23	E_1	2(11.76)	6(31.58)	8(22.22)	5(21.74)	4(18.18)	9(20.0)
	E_2	6(35.30)	5(26.32)	11(30.56)	2(8.69)	5(22.73)	7(15.55)
	E_3	0	4(21.05)	4(11.11)	1(4.35)	3(13.64)	4(8.39)
	E_4	6(35.30)	1(5.26)	7(19.44)	6(26.09)	7(31.82)	13(28.89)
	E_5	2(11.76)	3(15.79)	5(13.89)	1(4.35)	0	1(2.22)
	E_6	1(5.88)	0	1(2.78)	6(26.09)	2(9.09)	8(17.78)
	E_7	0	0	0	2(8.69)	1(4.54)	3(6.67)
	Total	17(100)	19(100)	36(100)	23(100)	22(100)	45(100)

(Percentages are shown in brackets)

3 CLUSTER–WISE DISTRIBUTION OF PERSONS IN THE SAMPLE BY THEIR OCCUPATION

The occupation of a person, generally, affects his quality of life and the standard of living. This, in turn, has its impact on the health status of the person. For example, a blue collar worker engaged in manual work may be more susceptible to ailments such as respiratory and infectious diseases, where as, a white collar worker may be susceptible to diseases of heart, diabetes, mental tension and stress, etc.

In the present study a sample of 1726 persons in 291 households in slum and non–slum areas of various clusters of localities in Delhi has been drawn. The Table 19 provides the list of 28 occupations, which we club together into four categories for the purposes of analysis. The cluster–wise distributions of persons by occupation categories are given in Table 20.

A brief concluding note in the following tries to highlight the major observation regarding the occupation of all sample clusters.

It is evident from the tables that the largest number of White Collar I workers were found in non–slum areas of cluster 16, (83.33%), where the localities were Inderpuri, Subroto Park, Dhaula Kuan and Bapu Dham.

In the slum areas there were very few white collar I workers, excepting cluster 2 where (37.50%) of the workers belong to the above mentioned category which is the largest figure compared to the other clusters. The areas are Malkagang, Sabjimandi, Kharia Mohalla, Vivekanand Puri, Sarai Rohilla, Model Basti, Azad Market, Pahari Dhiraj and Sadar Bazar.

The highest percentage of white collar II workers were found in cluster 14 of the non–slum areas and in cluster 22 in the slum areas that is (54.17%) and (50.00%) respectively. The areas are Lajpat Nagar, Andrewsganj, Kotla Mubarakpur, Sadiqnagar, Kalkaji and Madangir etc.

TABLE 19

OCCUPATION CATEGORIES

OCCUPATIONAL CATEGORIES		
White Collar I	1	Professionals (Architects, Engineer, Social Scientists, Lawyer, Teachers)
	2	Technicians, Medical Practitioners, Administrative Officers, Government Officials
	3	Working Proprietors (Managers and Directors)
	4	Administrative Executives (Pvt)
White Collar II	5	Clerical (Steno, Typist, Clerk, Peon, Receptionists etc.)
	6	Transport and Communication (Supervisor, guards, Conductors etc)
	7	Merchants/Shopkeepers/Salesman/Shop Assistant
	8	Insurance, Real Estate Agents, Money Lenders
Blue Collar I	9	Housekeepers, Matrons etc.
	10	Cooks, Waitors etc.
	11	Maids
	12	Launderers/Dry cleaners
	13	Hair Dressers
	14	Gateman/Watchman
	15	Primary Activity
	16	Food/Beverage Processor
	17	Tailors/Dressmakers
	18	Tanners
	19	Carpenters
	20	Blacksmith
	21	Machine and Electronic fitters
	22	Plumbers
	23	Weavers
	24	Painters
	25	Bricklayer
	26	Drivers
Blue Collar II	27	Labourers
	28	Sweepers/cleaners

TABLE 20

CLUSTER–WISE OCCUPATION OF THE PERSONS INCLUDED IN THE SAMPLE

Cluster	Occupation	Slum	Non–Slum
1	White Collar I	0(0.00)	11(61.11)
	White Collar II	0(0.00)	2(11.11)
	Blue Collar I	6(85.71)	4(22.22)
	Blue Collar II	1(14.29)	1(5.56)
	Total	7	18
2	White Collar I	9(37.50)	20(80.00)
	White Collar II	1(4.17)	3(12.00)
	Blue Collar I	7(29.17)	2(8.00)
	Blue Collar II	7(29.17)	0
	Total	24	25
3	White Collar I	0(0.00)	12(44.44)
	White Collar II	2(14.29)	7(25.93)
	Blue Collar I	7(50.00)	2(7.41)
	Blue Collar II	5(35.71)	6(22.22)
	Total	14	27
9	White Collar I	3(6.67)	19(36.54)
	White Collar II	10(22.22)	20(38.46)
	Blue Collar I	14(31.11)	9(17.31)
	Blue Collar II	18(40.00)	4(7.69)
	Total	45	52
10	White Collar I	2(5.13)	29(63.04)
	White Collar II	3(7.69)	6(13.04)
	Blue Collar I	14(35.90)	8(17.39)
	Blue Collar II	20(51.28)	3(6.52)
	Total	39	46
11	White Collar I	0(0.00)	–
	White Collar II	0(0.00)	–
	Blue Collar I	1(100.00)	–
	Blue Collar II	0(0.00)	–
	Total	1	

Cluster	Occupation	Slum	Non–Slum
12	White Collar I	1(16.67)	4(57.14)
	White Collar II	1(16.67)	2(28.57)
	Blue Collar I	0(0.00)	1(14.29)
	Blue Collar II	4(66.67)	0
	Total	6	7
14	White Collar I	0(0.00)	8(33.33)
	White Collar II	9(37.50)	13(54.17)
	Blue Collar I	11(45.83)	3(12.50)
	Blue Collar II	4(16.67)	0(0.00)
	Total	24	24
15	White Collar I	1(4.35)	15(57.69)
	White Collar II	6(26.09)	7(26.92)
	Blue Collar I	7(30.43)	3(11.54)
	Blue Collar II	9(39.13)	1(3.85)
	Total	23	26
16	White Collar I	0(0.00)	10(83.33)
	White Collar II	3(21.43)	2(16.67)
	Blue Collar I	1(7.14)	0(0.00)
	Blue Collar II	10(71.43)	0(0.00)
	Total	14	12
20	White Collar I	0(0.00)	0(0.00)
	White Collar II	0(0.00)	0(0.00)
	Blue Collar I	0(0.00)	0(0.00)
	Blue Collar II	2(100.00)	3(100.00)
	Total	2	3
22	White Collar I	0(0.00)	0(100.00)
	White Collar II	2(50.00)	0(0.00)
	Blue Collar I	0(0.00)	0(0.00)
	Blue Collar II	2(50.00)	0(0.00)
	Total	4	1
23	White Collar I	2(18.18)	7(58.33)
	White Collar II	2(18.18)	1(8.33)
	Blue Collar I	3(27.27)	3(25.00)
	Blue Collar II	4(36.36)	1(8.33)
	Total	11	12

Figures in the brackets represent percentage

The grand total 467 is the number of persons in the sample who are engaged in a certain occupation. The total number of persons in the sample is 1726.

CHAPTER VI

CLUSTER AND AGE–WISE DISTRIBUTION OF DISEASES IN SLUM AND NON–SLUM AREAS OF U.T./N.C.T. ACCORDING TO THE SAMPLE SURVEY

1 CLASSIFICATION OF DISEASES

In this chapter we use primary data collected through the sample survey (described in the earlier chapter) of households and persons from various clusters of localities in Delhi and examine their disease pattern. The data on diseases based on responses of persons suffer from problems associated with recalling events or episodes of illness. In many cases the responses pertaining to tuberculosis, leprosy, psychiatric disorders, gyneacological problems, STD/VD or AIDS went almost unreported for obvious reasons of social stigma attached with them. The chapter looks into three major aspects pertaining to diseases:

a) occurrence of diseases in general, in the slum and non–slum areas;

b) prevalence of diseases according to age–groups; and

c) cluster–wise disease pattern.

The reported diseases must be reclassified and grouped together to make them manageable. The classification of diseases adopted for the present analysis closely follows the International Statistical Classification of Diseases (ICD)– the 10th revision and other studies by the World Health Organization (W.H.O.) reported in detail in the appendix to this chapter.

The following ten major categories have been identified:

1) **Diseases related to the circulatory system**– hypertension, cardiovascular system, blood sugar, kidney related problems, paralysis and heart ailments,

2) **Respiratory diseases**– asthma, bronchitis, pneumonia, dust allergy, tuberculosis (lung), respiratory infection

3) **Gastroenteritis**– digestive disorder, gastric, indigestion and gastric acidity

4) **Skin diseases**

5) **Communicable/infectious diseases**– typhoid, malaria, cholera, measles, chickenpox, jaundice, cold and cough, urinary and general infection, STD (sexually transmitted diseases) and VD (venereal diseases).

6) **Fever**

7) **Minor illness/weakness**

8) **Deficiency related diseases**– iodine deficiency (goitre) etc.

9) **Others**– malignancy, disorders in nervous system, eye problem, gynaecological problem

10) **Dropsy**

2 DISTRIBUTION OF CLASSIFIED DISEASES IN SLUM AND NON SLUM AREAS IN DELHI

Our sample survey of households and persons in slum and non–slum areas of Delhi shows the following distribution of diseases:

TABLE 1

DISTRIBUTION OF CLASSIFIED DISEASES IN SLUM AND NON–SLUM AREAS OF DELHI

S.No.	Classified Diseases	Slum	Non–slum	Total
1.	Circulatory	14 (19.44)	58 (80.56)	72
2.	Respiratory	24 (58.54)	17 (41.46)	41
3.	Gastroenteritis	25 (48.08)	27 (51.92)	52
4.	Skin	14 (73.68)	5 (26.32)	19
5.	Communicable	24 (61.54).	15 (38.46)	39
6.	Fever	37(62.71)	22 (37.29)	59
7.	Minor	11 (68.75)	5 (31.25)	16
8.	Deficiency	18 (39.13)	28 (60.87)	46
9.	Others	11 (61.11)	7 (38.89)	18
10.	Dropsy	12 (66.67)	6 (33.33)	18

(Figures in brackets are percentages)

We observe that 80.56% of cases of diseases of circulatory system were reported from non–slum areas and 19.44% from slum areas. Significantly higher proportion in non–slum areas may be attributed to the sedentary life style of people in these areas, which involves more of mental work, lots of stress, strain and tension, etc. and negligible amount of manual or physical labour.

The proportion of cases of respiratory diseases was 58.34% in slum areas and 41.46% in non–slum areas. Poor living conditions with damp housing, poor sanitation, congestion, etc., in slums lead to a large number of cases of respiratory diseases. As the data show, non–slum areas have also a large number of cases of respiratory diseases. Deteriorating environmental conditions, increase in air and water pollution cause respiratory diseases in slums and non–slum areas.

Gastroenteritis cases in slum and non–slum areas of Delhi are 48.08% and 51.92%, respectively.

There is a very high proportion (73.68%) of cases of skin diseases in slum areas compared to 26.32% in non–slum areas.

Communicable diseases, fever, etc. have higher proportions in slum than in non–slum areas.

TABLE 2

CLUSTERWISE DISTRIBUTION OF DISEASES IN THE SLUM AND NON–SLUM AREAS OF U.T./N.C.T. OF DELHI ACCORDING TO SAMPLE SURVEY

Cluster	1		2		3		9		10		12		14		15		16		20		22		23	
Disease category	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
1	1	7	3	3	1	6	1	9	3	13	0	1	0	7	2	8	2	1	–	–	0	1	1	2
2	0	1	2	2	1	1	4	4	9	6	0	0	5	1	0	0	0	2	–	–	0	0	3	0
3	2	2	1	1	2	3	4	5	7	6	2	1	2	0	1	3	1	1	–	–	1	1	1	4
4	0	0	1	0	2	2	3	1	3	0	0	0	3	0	2	2	0	0	–	–	0	0	0	0
5	0	1	4	1	1	2	4	1	5	2	1	1	2	2	6	4	1	1	–	–	0	0	0	0
6	1	3	4	2	2	4	10	5	6	3	0	0	3	2	8	3	2	0	–	–	1	0	0	0
7	0	3	4	0	0	1	3	0	3	1	0	0	0	0	1	0	0	0	–	–	0	0	0	0
8	0	2	1	3	1	0	5	3	5	4	0	3	0	0	1	2	3	7	–	–	0	0	2	0
9	0	1	1	0	1	1	0	1	7	0	0	1	1	0	0	1	0	0	–	–	0	0	0	0
10	0	0	0	0	0	0	0	0	0	1	0	0	7	0	5	5	0	0	–	–	0	0	0	0
TOTAL	4	20	21	12	11	20	34	29	48	36	3	7	23	12	26	28	9	12	–	–	2	2	7	6

S Slum
NS Non–slum

TABLE 3

AGE–WISE DISTRIBUTION OF DISEASES IN THE SLUM AND NON SLUM AREAS OF U.T./N.C.T. OF DELHI ACCORDING TO THE SAMLE SURVEY

Age group	< 5		6–9		10–14		15–19		20–24		25–29		30–44		45–59		> 60	
Disease	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S
1	–	–	–	–	1	–	3	–	2	1	–	2	8	7	24	2	20	2
2	3	2	2	–	2	3	2	2	–	–	1	1	2	6	2	4	3	6
3	5	9	3	2	3	4	–	2	3	2	5	3	5	2	1	1	2	–
4	2	3	2	2	1	1	–	–	–	2	–	–	–	2	–	2	–	2
5	3	4	2	2	2	2	1	4	–	3	1	3	3	2	2	2	1	2
6	3	4	4	8	3	7	5	5	3	2	–	6	4	2	–	3	–	–
7	1	1	1	1	1	3	–	–	–	1	–	1	1	2	1	2	–	–
8	1	3	–	4	–	–	–	–	1	1	2	2	9	1	10	4	5	3
9	–	–	–	–	–	1	1	2	2	3	–	2	2	1	–	1	2	1
10	–	–	1	2	2	3	–	2	–	1	1	–	2	4	–	–	–	–

NS Non Slum
S Slum

APPENDIX TO CHAPTER VI

VI.1 The International Statistical Classification of Diseases (ICD)

The **Tenth Revision of the International Statistical Classification of Diseases (ICD) and Related Health Problems** published by the World Health Organization in 1992 is the latest in a series that was formalized in 1893 as the Bertillon Classification or International List of Causes of Death. The list includes the following:

I. Certain infectious and parasitic diseases

II. Neoplasms

III. Diseases of the blood and blood–forming organs and certain disorders involving the immune mechanism

IV. Endocrine, nutritional and metabolic diseases

V. Mental and behavioural disorders

VI. Diseases of the nervous system

VII. Diseases of the eye and adnexa

VIII. Diseases of the ear and mastoid process

IX. Diseases of the circulatory system

X. Diseases of the respiratory system

XI. Diseases of the digestive system

XII. Diseases of the skin and subcutaneous tissue

XIII. Diseases of the musculoskeletal system and connective tissue

XIV. Diseases of the genitourinary system

XV. Pregnancy, child birth and the puerperium

XVI. Certain conditions originating in the perinatal period.

XVII. Congenital malformations, deformations and chromosomal abnormalities

XVIII. Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified

XIX. Injury, poisoning and certain other consequences of external causes

XX. External causes of morbidity and mortality

XXI. Factors influencing health status and contact with health services

VI.2 **World Health Report (1997) Categories**

The World Health Report (1997), **Conquering Suffering Enriching Humanity,** published by the World Health Organization have categorized diseases as:

I. Diseases of the circulatory system

II. Diseases of the respiratory system

III. Infectious and parasitic diseases

IV. Other unknown causes

V. Cancer (malignancy)

VI.3 **NCAER Categorization**

A study by the National Council of Applied Economic Research (NCAER), New Delhi has grouped the diseases as

I. Infectious Diseases: typhoid, cholera, acute gastroenteritis, malaria, jaundice, numps, measles, chicken pox, tuberculosis, pneumonia, bronchitis, certain type of respiratory infections, cold and cough, leprosy, urinary and general infections, sexually transmitted diseases.

II. Non–Infectious Diseases: high blood pressure, heart ailments, paralysis, diabetes, kidney related problems, cardio–vascular diseases, arthiritis, rheumatism, gastric, acidity, indigestion.

III. Fevers and others

VI.4 **Sekhar (1995) Grouping of Diseases**

A study by P. Satya Sekhar entitled, "Mortality and Health Care in Andhra Pradesh", published in **Health Care Services Management** edited by A. Ranga Reddy, Delhi Publishing House, 1995 (pp. 121–127). grouped diseases as

I. Water borne diseases– cholera, dysentery, diarrhoea, gastro–enteritis, jaundice, influenza

II. Insect bite diseases– malaria

III. Viral diseases– diphtheria, measles, typhoid and paratyphoid

IV. Cardiac diseases

V. Cerebro– vascular diseases

VI. Communicable diseases– tuberculosis, s.d. and others

VII. Communicable by generation–bronchitis, asthma and diabetes.

Part B

STATE LEVEL MACRO ANALYSIS OF HEALTH SCENARIO IN INDIA

CHAPTER VII

THE COMMUNITY HEALTH STATUS AND INDICATORS OF HEALTH OF A COMMUNITY

Variations in health status of people in developing and developed countries have been analysed by many authors in recent years.[1] Generally, the expectation of life at birth and mortality rates are used as 'indicators' of health of the people. It is supposed that communities with higher life expectancy and lower mortality rates possess better health status. However, it is also recognised that neither the life expectancy nor mortality rates adequately measure health status of the people. Health status of the people may improve even if the life expectancy does not increase. The mortality rates do not always reflect the true picture of health status, as the reported death statistics, generally, include deaths due to suicides, murders, earthquakes, floods and other unnatural causes, which have nothing to do with the health status of the people.[2] Moreover, the mortality and morbidity rates do not always exhibit the same pattern. It has been observed that populations with low mortality rates often report high morbidity rates, implying poor health status of the people. In fact, communities with high income generally report low mortality rates. However, it should be noted that high income alone does not necessarily imply better health status of the people.[3] It depends on how well the income is consumed. If additional income is used to consume more of harmful goods, such as drugs, alcohol, cigarettes, etc., it will lead to higher morbidity and will have adverse effect on the health status. Income and educational status of the people, better medical care, more equitable distribution of income and age structure of the population jointly determine the community health status.

The community health status is a composite variable.

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1 For details see Sen (1981), Dasgupta and Wheale (1992), Dasgupta (1990), Kakwani (1973) and Rao and Bhat (1991).

2 For details of weaknesses of these statistics see Chen and Bryant (1975), Sullivan (1966) and Moriyama (1968).

3 Cf. Sen (1981).

In the present study, we treat the community health status as an abstract conceptual variable which is not directly measurable. It is a 'latent' variable which is determined by a large number of variables which are measured with a reasonable degree of accuracy. The income level of the people and inequality of their income distribution, food habits of the people and their nutritional intake, living conditions and sanitation, medical care facilities available to the people, the physical and natural environment of the region, the age structure of the population, etc., all affect the health status of the community, among other variables. These variables are mutually inter–correlated and they may themselves be determined by several other variables. For example, the environment depends on the climatic factors such as the temperature, rainfall, humidity, etc., the flora and fauna of the region and also the level of industrial and vehicular pollution of air, water, soil and noise; the living conditions may be described in terms of the kind of housing, sanitation, quality of water used; medical care facilities may be measured in terms of availability of doctors and nurses per person and the number of health clinics and hospitals in the region.

Since the number of variables affecting the health status of people is too large and data on many of them may not be available, we should restrict our analysis to only a few causal variables. In the present analysis we postulate that the health status of people is linearly determined by

1) the level of education of the people (measured by the enrolment ratio at the level of middle school education)– **LED**

2) the expenditure on health by the state (measured as per capita expenditure on health) – **PHE**

3) the income level of the people (measured by per capita consumption expenditure) – **PCE**

4) the inequality of the income distribution (measured by the GINI coefficient of the inequality of consumption expenditure) – **GC**

5) the population per primary health centre – **PPP**

6) population per doctor – **PPD**

and

7) percent of population above sixty year of age – **PPO**

We use state–wise data on these variables for fifteen states of India:

Andhra Pradesh	Karnataka	Punjab
Assam	Kerala	Rajasthan
Bihar	Madhya Pradesh	Tamil Nadu
Gujarat	Maharashtra	Himachal Pradesh
Haryana	Orrisa	West Bengal

for the census years 1971, 1981 and 1991.

According to the MIMIC model, pioneered by Goldberger and described in the next chapter, we postulate that the latent variable H* (the state level health status index) is linearly determined by seven causal variables listed above; and the indicator variables (life expectancy – **LE**, crude death rate – **CDR**, and infant mortality rate – **IMR**) are regressed on H*. Thus in the present case, the MIMIC model is a linear structural model with four equations in four endogenous variables (H*, LE, CDR and IMR) and seven exogenous (causal) variables (LED, PHE, PCE, GC, PPP, PPD, and PPO).

Goldberger obtained conditions of identifiability of the structural parameters. Under these conditions he obtained their maximum likelihood estimates. Details of the method are given in the next chapter. As noted there, the likelihood equations turn out to be highly non–linear. Their explicit analytical solutions cannot be obtained; however, one may obtain numerical solutions by adopting an appropriate iterative scheme.

The Chapter 3 proposes estimation of H* as a weighted average of principal components of the causal variables. In fact, principal components are normalized linear functions of the causal variables such that the sum of squares of the coefficients is unity. Details of the method of computing principal components are given in Chapter 3. Since we have seven causal variables, we can compute at most seven principal components. In general, the first principal component accounts for the largest proportion of variation in all causal variables, the second principal component accounts for the second largest proportion, and so on. All seven principal components, together, account for 100% of the total variation among all seven causal variables.

The principal components are mutually orthogonal.

If $P_1, \ldots, P_7$ are the principal components, their weighted average

$$\frac{\lambda_1 P_1 + \ldots + \lambda_7 P_7}{\lambda_1 + \ldots + \lambda_7} = \hat{H}^*$$

is an estimator of H*, where $V(P_1) = \lambda_1, \ldots, V(P_7) = \lambda_7$ are variances of $P_1, \ldots, P_7$, respectively.

The computational details of principal components are given in Chapter 4 and those of health status indices for fifteen states and for years 1971, 1981 and 1991 are given in Chapter 5.

We observe that $\hat{H}^*$ has consistently increased over the years for Kerala, Maharashtra and Tamil Nadu, where as it has consistently declined over years for Assam and Madhya Pradesh. Punjab had second rank in 1981 and third in 1991 improving considerably over their record (of 15th rank) in 1971. Karnataka maintained their ranks at 7 in 1971, 9 in 1981 and 5 in 1991.

In Chapter 6 we examine the relationships of indicators of health (viz., life expectancy, crude death rates and infant mortality rates) with the health status index. It turns out that $\hat{H}^*$

is significantly correlated with the life expectancy. The crude death rate in also significantly correlated with $\hat{H}^*$ in 1991, but its relationship with $\hat{H}^*$ is not significant in 1971 and 1981. It has been noted that data on CDR are dubious as they include deaths due to factors (like accidents, suicides and murders, etc.) which have nothing to do with the health status of the states. The infant mortality rates are also significantly correlated with $\hat{H}^*$ in 1991.

Briefly, the results are fairly as expected. But there is need for a more detailed analysis. As noted in the text the health status of a state depends on many other factors. We had to restrict our analysis to only a few causal variables as data in greater detail are not available at the state level.

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CHAPTER VIII

ESTIMATION OF THE HEALTH STATUS INDEX: MAXIMUM LIKELIHOOD METHOD

An approach to over come the difficulty posed by 'latent variables' is found in the MIMIC (multiple indicators and multiple causes) models of a single latent variable pioneered by Goldberger (1971, 1972 and 1974) and subsequently extended by many authors; eg., van Vliet and van Praag (1987), Robinson (1974), Zellner (1970), Wolfe (1981), Chan–fu–chen (1981).

The MIMIC model postulates the latent variable (for example, H*: the community health status index) as a function of exogenously determined causal variables x_1, --- x_K:

$$(1) \quad H^* = f(x_1, \text{---} x_K, u),$$

where f(.) indicates the form of the relationship and u is the stochastic error in the equation.

The error in the equation arises due to omission of some causal variables from the equation, or, due to misspecification of the form of the relationship, or, due to errors in the measurement of causal variables.

The model also specifies a set of equations corresponding to the indicator variables which are supposed to be affected by H* and any other exogenous variables:

$$(2) \quad \begin{aligned} y_1 &= f_1 (H^*, z, v_1) \\ &\vdots \\ y_G &= f_G (H^*, z, v_G) \end{aligned}$$

where f_1 (.),---,f_G (.) represent the form of the relationships, z is a vector of some exogenous variables and v_1,---, v_G are errors in the equations.

The MIMIC model (1)–(2) represents a set of interdependent structural equations.

In order to complete the specification of the model, we must also specify the form of the probability distribution of the errors u, v_1 ..., v_G.

Since H* is not observable, but is determined as in (1), we substitute for H* in (2) from (1) and obtain the reduced form of the structural system. As a consequence the reduced form parameters are non–linear functions of parameters of the structural system.

Under appropriate conditions of identifiability of the parameters, we may estimate them jointly by the method of maximum likelihood. (For details of the method, see the Appendix A at the end of this chapter).

Jöreskog and Goldberger (1975) have worked out maximum likelihood estimators of parameters of the structural system, where the form of relationships in (1) and (2) is linear and the errors in the equations follow a multivariate normal law.

The authors have obtained the mean and variance of the conditional distribution, of H*, given the values of y's and x's. (z is not included in the specification of the model)

The estimator of the conditional mean of H*, given the values of y_1, ..., y_G and x_1, ..., x_K is used as an estimator of H*.

Maximum likelihood estimator of H* possesses optimal properties for large samples. However, the likelihood equations are found to be highly non–linear, which can be solved numerically but not analytically. It is not possible to obtain an explicit analytical expression for H*.

APPENDIX OF CHAPTER VIII

MAXIMUM LIKELIHOOD ESTIMATION OF PARAMETERS IN LINEAR MODELS INVOLVING A LATENT VARIABLE

An interesting treatment of linear models involving a latent variable has been pioneered by Goldberger (1973) and Jöreskog and Goldberger (1975). They analysed a multiple indicators and multiple causes of a single latent variable model, called a MIMIC model.

Suppose the latent variable y* is linearly determined by K observable 'causes' $x_1, ..., x_K$. If T observations are available on x's, we may write

(A.1) $$y_t^* = \alpha_1 x_{1t} + ... + \alpha_K x_{Kt} + \epsilon_t$$

for t = 1, ..., T; where $\alpha_1, ..., \alpha_K$ are constant coefficients and ϵ_t is stochastic error. It is further postulated that y* determines a set of M **indicator** variables $y_1, ..., y_M$ as

(A.2)
$$\begin{aligned} y_{1t} &= \beta_1 y_t^* + u_{1t} \\ &\cdots \quad \cdots \\ y_{Mt} &= \beta_M y_t^* + u_{Mt} \end{aligned}$$

where $\beta_1, ..., \beta_M$ are constant coefficients and $u_1, ..., u_M$ are stochastic errors.

The assumptions of the model are

i) $E\,\epsilon_t = 0$ and $E\,u_{1t} = \text{---} = E\,u_{Mt} = 0$ for t = 1, ..., T,

ii) $V\epsilon_t = 1$, $Vu_{it} = \sigma_{ii}$, $Cov\,(\epsilon_t, u_{it}) = 0$;

$$\text{Cov}\ (\epsilon_t, \epsilon_{t'}) = 0,\ \text{Cov}\ (\epsilon_t, u_{it'}) = 0,$$

$$\text{Cov}\ (u_{it}, u_{jt'}) = 0 \text{ if } t \neq t'; \text{ and}$$

$$\text{Cov}\ (u_{it}, u_{jt}) = 0 \text{ for } i, j = 1, \ldots, M.$$

iii) $\text{Cov}\ (x_{kt}, \epsilon_{t'}) = 0$ and $\text{Cov}\ (x_{kt}, u_{it'}) = 0$ for all k's, i's and t's,

and for the sake of convenience we assume that all variables, y_t's and x_t's, are measured from their means.

If we substitute for y_t^* from (A.1) in (A.2) we get the reduced form as

$$\begin{aligned} y_{1t} &= \beta_1 \alpha_1 x_{1t} + \ldots + \beta_1 \alpha_K x_{Kt} + (\beta_1 \epsilon_t + u_{1t}) \\ &\ldots \qquad \ldots \\ y_{Mt} &= \beta_M \alpha_1 x_{1t} + \ldots + \beta_M \alpha_K x_{Kt} + (\beta_M \epsilon_t + u_{Mt}) \end{aligned} \tag{A.3}$$

or,

$$\begin{aligned} y_{1t} &= \pi_{11} x_{1t} + \ldots + \pi_{1K} x_{Kt} + v_{1t} \\ &\ldots \qquad \ldots \\ y_{Mt} &= \pi_{M1} x_{1t} + \ldots + \pi_{MK} x_{Kt} + v_{Mt} \end{aligned} \tag{A.4}$$

where

$$\pi_{ik} = \beta_i \alpha_k,\ i = 1, \ldots, M \text{ and } k = 1, \ldots, K \tag{A.5}$$

are reduced form coefficients, and

$$v_{it} = \beta_i \epsilon_t + u_{it},\ i = 1, \ldots, M \tag{A.6}$$

are reduced form disturbances, for t = 1, ... , T.

It should be noted that the reduced form coefficients are nonlinear functions of structural coefficients and reduced form disturbances are linear functions of structural disturbances.

It follows that

(A.7) $E\, v_{it} = \beta_i\, E\, \epsilon_t + E\, u_{it} = 0$ and $Cov\,(v_{it}, x_{kt}) = 0$ and

(A.8) $Var\, v_{it} = \omega_{ii} = \beta_i^2 + \sigma_{ii}$, $Cov\, v_{it}\, v_{jt} = \omega_{ij} = \beta_i \beta_j$ and $Cov\, v_{it}, v_{jt'} = 0$

for $i \neq j = 1, \ldots, M$ and $t \neq t' = 1, \ldots, T$.

We may apply straight forward OLS (Ordinary Least Squares) to (A. 4) to obtain the best linear unbiased estimates of π_{ik}'s and ω_{ij}'s for i, j = 1, ... , M and k = 1, ... , K.

Can we uniquely determine the structural parameters (viz., β_i's, α_k's and σ_{ii}'s) from the knowledge of π_{ik}'s and ω_{ij}'s?

This is the **identification problem**.

It has been shown by Goldberger (1973) that the structural parameters are not identifiable if M<3. They are just – identified if M = 3 and are over – identified if M>3.

He obtained maximum likelihood estimates of the parameters and analyzed their large sample properties.

Derivation of the Maximum Likelihood Estimates

In order to derive the maximum likelihood estimates of the structural parameters we write the model, (A.1) and (A.2), in vector form as

(A.9) $y_t^* = \alpha' x_t + \epsilon_t$ and

(A.10) $y_t = \beta y_t^* + u_t$

where

$$(A.11) \qquad x_t = \begin{pmatrix} x_{1t} \\ \vdots \\ x_{Kt} \end{pmatrix}$$

is the vector of t–th observations on $x_1,\ldots x_K$, and

$$(A.12) \qquad \alpha = \begin{pmatrix} \alpha_1 \\ \vdots \\ \alpha_K \end{pmatrix}$$

is the vector of coefficients; y_t^* is the 'scalar' latent variable and ϵ_t is the 'scalar' error.

We also define

$$(A.13) \qquad y_t = \begin{pmatrix} y_{1t} \\ \vdots \\ y_{Mt} \end{pmatrix}$$

as the vector of t–th observations on M indicator variables,

$$(A.14) \qquad \beta = \begin{pmatrix} \beta_1 \\ \vdots \\ \beta_M \end{pmatrix}$$

as the vector of coefficients and

$$(A.15) \qquad u_t = \begin{pmatrix} u_{1t} \\ \vdots \\ u_{Mt} \end{pmatrix}$$

as the vector of stochastic errors.

Then the assumptions of the model imply

i) $E\,\epsilon_t = 0,\ E\,u_t = 0,$

ii) $E\,\epsilon_t\,u_t = 0,\ E\,\epsilon_t\,x_t = 0,\ E\,x_t\,u_t' = 0$ and

iii) $V\epsilon_t = 1,\ Eu_t\,u_t' = \Sigma = \begin{pmatrix} \sigma_{11} \cdots 0 \\ 0 \cdots \sigma_{MM} \end{pmatrix}$

is diagonal

$E\,u_t\,u_{t'}' = 0$ and $E\,\epsilon_t\,u_{t'}' = 0$ for $t \neq t'$.

The reduced form of the model in vector form is

$$(A.16) \quad y_t = \Pi' x_t + v_t$$

where $\Pi' = \beta\alpha'$, or

$$(A.17) \quad \Pi = \alpha\beta'$$

is the matrix of reduced form coefficients and

(A.18) $v_t = \beta\, \epsilon_t + u_t$

is the vector of reduced form disturbances. We have

(A.19) $E\, v_t = \beta\, E\epsilon_t + E\, u_t = 0$

(A.20) $E\, v_t\, v_t' = \beta\, \beta' + \Sigma = \Omega$, say, and $E\, v_t\, v_{t'}' = 0$

for $t \neq t' = 1, \ldots, T$.

For all observations together the reduced form (A.16) may be written as

(A.21) $Y = X\Pi + V$

where

$$(A.22)\quad Y = \begin{pmatrix} y_1' \\ \vdots \\ y_t' \\ \vdots \\ y_T' \end{pmatrix} = \begin{pmatrix} y_{11} \cdots y_{M1} \\ \vdots \\ Y_{1T} \cdots Y_{MT} \end{pmatrix}$$

$$X = \begin{pmatrix} x_1' \\ \vdots \\ x_T' \end{pmatrix} = \begin{pmatrix} x_{11} \cdots x_{K1} \\ \vdots \\ x_{1T} \cdots x_{KT} \end{pmatrix}$$

and

$$V = \begin{pmatrix} v_1' \\ \vdots \\ v_T' \end{pmatrix} = \begin{pmatrix} v_{11} \cdots v_{M1} \\ \vdots \\ v_{1T} \cdots v_{MT} \end{pmatrix} .$$

It should be noted that

(A.23) $E\,V = 0$ and $\frac{1}{T}\,EV'V = \Omega$.

For maximum likelihood estimation we require the assumption that

the T rows of V are independently and identically distributed according to an M dimensional normal law with mean vector zero and a positive definite covariance matrix Ω.

Then the joint distribution of all rows of V is

(A.24) $(2\pi)^{(-1/2)MT} \mid \Omega \mid^{(-1/2)T} \exp\,[(-\tfrac{1}{2})\,\mathrm{tr}\,V\,\Omega^{-1}\,V']\,dV;$

where 'tr' indicates the trace of a matrix (i.e. the sum of the diagonal elements of the matrix). Using (A.21) as a set of transformation equations, and noting that the jacobian of the transformation is unity, we obtain the likelihood function of parameters, Π and Ω, for a given sample, as

(A.25) $L\,(\Pi, \Omega \mid y's \text{ and } x's) =$
$(2\pi)^{(-1/2)MT} \mid \Omega \mid^{(-1/2)T} \exp\,[(-1/2)\,\mathrm{tr}\,\Omega^{-1}\,(Y-X\Pi)'\,(Y-X\Pi)].$

Since log L is a monotonic function of L, the values of the parameters which maximize log L also maximize L. Therefore, let us consider

(A.26) $\log L = -\frac{1}{2} MT \log 2\pi - \frac{1}{2} T \log |\Omega| - \frac{1}{2} T \text{ tr } \Omega^{-1} W$

where

(A.27) $W = \frac{1}{T} (Y - X\Pi)' (Y - X\Pi)$.

Maximization of log L is equivalent to minimization of

(A.28) $\ell = -\frac{2}{T} \log L = C + \log |\Omega| + \text{tr } \Omega^{-1} W$

with respect to the parameters, where C=M log 2π.

Let us write

(A.29) $\Pi = \alpha\beta'$ and $\Omega = \beta\beta' + \Sigma$

in (A.28) and obtain those values of α, β and Σ for which ℓ is minimum. According to the principles of maxima and minima we must have

(A.30) $\frac{\partial \ell}{\partial \alpha} = 0, \frac{\partial \ell}{\partial \beta} = 0$ and $\frac{\partial \ell}{\partial \Sigma} = 0$

simultaneously.

We proceed step–wise as follows.

First of all let us see that

(A.31) $\frac{\partial \ell}{\partial \alpha} = \frac{\partial}{\partial \alpha} (\text{tr } \Omega^{-1} W)$

as log $|\Omega|$ is independent of α.

We write

(A.32) $\Omega^{-1}W = \Omega^{-1} (Y-X\alpha\beta')' (Y-X\alpha\beta')/T$

so that

(A.33) $tr\Omega^{-1} W = tr (\Omega^{-1} Y'Y/T) - 2\alpha'(X'Y/T) \Omega^{-1}\beta + (\beta'\Omega^{-1}\beta) \alpha'(X'X/T) \alpha.$

Hence

(A.34) $\frac{\partial \ell}{\partial \alpha} = 0$

gives the maximum likelihood estimator

(A.35) $\hat{\alpha} = \frac{1}{\hat{\beta}'\hat{\Omega}^{-1}\hat{\beta}} (X'X)^{-1} X'Y\hat{\Omega}^{-1}\hat{\beta}$

of α, in terms of the estimates of β and Ω.

Lets us observe that

$$\Omega^{-1} = (\beta\beta' + \Sigma)^{-1} = \Sigma^{-1} - \frac{1}{1+\pi} \Sigma^{-1} \beta\beta'\Sigma^{-1}$$

(A.36) $\Omega^{-1}\beta = \frac{1}{1+\pi} \Sigma^{-1} \beta$ and $\beta'\Omega^{-1}\beta = \frac{\pi}{1+\pi}$

where

(A.37) $\pi = \beta'\Sigma^{-1} \beta.$

Also note that

(A.38) $|\Omega| = |\Sigma + \beta\,\beta'| = |\Sigma|\,(1+\beta'\Sigma^{-1}\beta)$

where $|.|$ indicates the determinant value of a matrix; cf. Dhrymes (1970), p.571.

Now, substituting $\hat{\alpha}$ for α in (A.28), we get

(A.39) $\ell^c = C + \log|\Sigma| + \log(1+\pi) + \text{tr}\,\Sigma^{-1}R - \frac{1}{1+\pi}\,\beta'\Sigma^{-1}R\Sigma^{-1}\,\beta - \frac{1}{\pi(1+\pi)}\beta'\Sigma^{-1}Q\Sigma^{-1}\beta$

as the concentrated likelihood function (value of ℓ) of β and Σ, where $\pi=\beta'\Sigma^{-1}\beta$, as defined above, and

$$R = \frac{1}{T}Y'Y,\ S = \frac{1}{T}\,Y'MY,\ Q = \frac{1}{T}\,Y'M^*Y$$

(A.40)

$M = I - M^*$, $M^* = X(X'X)^{-1}\,X'$ and $R = S + Q$.

Partially differentiating ℓ^c with respect to β and equating to zero, gives

(A.41) $(S+\hat{b}Q)\hat{\Omega}^{-1}\hat{\beta}=(1+\hat{a})\hat{\beta}$

where

(A.42) $\hat{b}=\frac{\hat{\pi}+1}{\hat{\pi}}$

and

(A.43) $\hat{a}=\hat{\beta}'\hat{\Omega}^{-1}(S-\hat{\Omega})\hat{\Omega}^{-1}\hat{\beta}+\frac{1}{T}\,\hat{\alpha}'X'X\hat{\alpha}$.

However, if we use

(A.44) $S = \hat{\Omega}$

the first term on the right of (A.43) vanishes, and we get

(A.45) $\hat{a}=\frac{1}{T}\,\hat{\alpha}'X'X\hat{\alpha}$

as on the right hand side of the equation (3.13), p. 632 of Jöreskog and Goldberger (1975).

It follows from (A.41) that $\hat{\beta}$ is the characteristic vector of the matrix $(S+\hat{b}Q)\hat{\Omega}^{-1}$ corresponding to the characteristic root $1+\hat{a}$. It has been shown by Goldberger (1974) that for maximum likelihood estimator of β we must choose the largest root. The solution is not explicit.

Next partially differentiating ℓ^c with respect to the elements of Σ, and using (A.44), we get

(A.46) $\hat{\sigma}_{ii}= r_{ii}+ (1+\hat{a})\hat{\beta}_i^2-2\ (s_i'\hat{\Omega}^{-1}\hat{\beta})\hat{\beta}_i-2\hat{b}(q_i'\hat{\Omega}^{-1}\hat{\beta})\hat{\beta}_i.$

for i = 1,..., M; where $\hat{\sigma}_{ii}$ is the i–th element on the diagonal of the matrix $\hat{\Sigma}$, r_{ii} is the element in the i–th row and i–th column of MxM matrix R, $\hat{\beta}_i$ is the i–th element of Mx1 column vector $\hat{\beta}$, s_i' and q_i' are the i–th rows of MxM matrices S and Q, respectively and $\hat{a}$ and $\hat{b}$ are as defined above in (A.45) and (A.42), respectively. It is easy to see that

(A.47) $(s_i'+ \hat{b}q_i')\hat{\Omega}^{-1}\hat{\beta}=(1+\hat{a})\hat{\beta}_i$

from (A.41). Hence

(A.48) $\hat{\sigma}_{ii}= r_{ii}-(1+\hat{a})\hat{\beta}_i^2$

for i= 1,..., M, as noted by Jöreskog and Goldberger (1975), equation (3.18), p. 633.

Since, (A.41) and (A.48) donot provide explicit solutions for $\hat{\beta}$ and $\hat{\Omega}$ we have to follow an iterative procedure to obtain estimates of the elements of $\hat{\alpha}$, $\hat{\beta}$ and $\hat{\Sigma}$.

Computation of Maximum Likelihood Estimates of Parameters in the MIMIC Model

The following iterative procedure has been proposed by Rao and Bhat (1991) for calculation of maximum likelihood estimates of parameters in the MIMIC model discussed above.

Step 1. Compute the following moment matrices from the set of observations on y's and x's:

$$R=\frac{1}{T}Y'Y,\ Q=\frac{1}{T}Y'M^{*}Y \text{ and } S=\frac{1}{T}Y'MY$$

where

$M^* = X(X'X)^{-1} X'$ and $M = I-M^*$;

and derive the vector of standard deviations

$$\begin{pmatrix} std(y_1) \\ \vdots \\ std(y_M) \end{pmatrix}$$

where

$$std(y_i) = \sqrt{\frac{1}{T}\sum_{t=1}^{T} y_{it}^2 - \bar{y}_i^{\,2}}$$

and

$$\bar{y}_i = \frac{1}{T} \sum_{t=1}^{T} y_{it}$$

for i = 1, ..., M.

Step 2. Choosing an initial value of δ as $\delta^{(0)} = 0.5$, obtain

$$\hat{\beta}^{(0)} = \begin{pmatrix} \hat{\beta}_1^{(0)} \\ \vdots \\ \hat{\beta}_M^{(0)} \end{pmatrix} = \begin{pmatrix} \delta^{(0)}\text{std}(y_1) \\ \vdots \\ \delta^{(0)}\text{std}(y_M) \end{pmatrix}$$

and

$$\hat{\Sigma}^{(0)} = \begin{pmatrix} \hat{\sigma}_{11}^{(0)} & \cdots & 0 \\ & \vdots & \\ 0 & \cdots & \hat{\sigma}_{MM}^{(0)} \end{pmatrix} = S - \hat{\beta}^{(0)}\hat{\beta}^{(0)\prime}$$

as initial values of β and Σ.

Compute $\hat{\pi}^{(0)} = \hat{\beta}^{(0)\prime} (\hat{\Sigma}^{(0)})^{(-1)} \beta^{(0)}$.

If the value of $\hat{\pi}^{(0)}$ lies between 0 and 1, the initial value $\beta^{(0)}$ of β is acceptable. Otherwise, repeat the process by reducing the value $\delta^{(0)}$ of δ to $\frac{1}{2}\delta^{(0)}$, $\frac{1}{4}\delta^{(0)}$, ... successively till an acceptable value of β is obtained.

Step 3. Compute

$$\hat{\alpha}^{(0)} = \frac{1}{\hat{\pi}^{(0)}} (X'X)^{-1}X'Y \, (\hat{\Sigma}^{(0)})^{-1} \hat{\beta}^{(0)}$$

and

$$\hat{\alpha}^{(0)} = \frac{1}{T} \hat{\alpha}^{(0)\prime} X'X \, \hat{\alpha}^{(0)}.$$

Step 4. Compute

$$\hat{S}_o^* = (\hat{\Sigma}^{(0)})^{-\frac{1}{2}} S (\hat{\Sigma}^{(0)})^{-\frac{1}{2}}$$

$$\hat{Q}_o^* = (\hat{\Sigma}^{(0)})^{-\frac{1}{2}} Q (\hat{\Sigma}^{(0)})^{-\frac{1}{2}}$$

$$\hat{\beta}_o^* = (\hat{\Sigma}^{(0)})^{-\frac{1}{2}} \hat{\beta}^{(0)}$$

$$\hat{\omega}_o = (1+\hat{\pi}^{(0)})\ (1+\hat{a}^{(0)}) - 1$$

Step 5. Obtain the largest characteristic root of the determinantal equation

$$|(\hat{S}_o^* + \hat{b}_0\ \hat{Q}_0^*) - (1 + \hat{\omega}_o)\ I| = 0$$

where

$$\hat{b}_0 = \frac{\hat{\pi}^{(0)}+1}{\hat{\pi}^{(0)}}$$

and the corresponding characteristic vector $\hat{\beta}^{(1)*}$ of $(\hat{S}_0^* + \hat{b}_0\ \hat{Q}_0^*)$ subject to the normalization restriction

$$\hat{\beta}^{(1)*\prime}\ \hat{\beta}^{(1)*} = \hat{\pi}^{(0)}.$$

Step 6. Compute

$$\hat{\sigma}_{ii}^{(1)} = r_{ii} - (1 + \hat{a}^{(0)})\ \hat{\beta}_i^{(1)^2}$$

for i=1, ..., M, where r_{ii} is the i–th diagonal element of R.

We repeat the process with fresh values $\beta^{(1)}$ and $\Sigma^{(1)}$, and obtain new values $\beta^{(2)}$ and $\Sigma^{(2)}$ of β and Σ, respectively and so on. The process is continued till the difference between successive values of β and Σ is smaller than a pre–fixed small value.

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CHAPTER IX

ESTIMATION OF COMMUNITY HEALTH STATUS INDEX, H*, AS A WEIGHTED AVERAGE OF PRINCIPAL COMPONENTS OF CAUSAL VARIABLES

As in the preceding chapter we suppose that H* is an abstract conceptual variable, which is not directly observable. However, we postulate that it is linearly determined by some causal variables $x_1, ..., x_K$. Changes in any one or more of the causal variables would affect the health status index.

If H* was observable we could regress H* on $x_1, ..., x_K$, and the coefficients of the causal variables would measure the marginal rates of change in H* for a small unit change in one of the causal variables, holding other variables constant. However, in the present case H* is not observable. Therefore, the usual regression theory is not directly applicable.

We propose to estimate H* as a weighted average of the principal components $P_1, ..., P_K$ of causal variables $x_1, ..., x_K$:

$$\hat{H}^* = \frac{\lambda_1 P_1 + ... + \lambda_K P_K}{\lambda_1 + ... + \lambda_K}$$

where $\lambda_1, ..., \lambda_K$ are variances of $P_1, ..., P_K$, respectively.

For a detailed discussion of principal component analysis we may refer to the Appendix B at the end of this chapter.

The principal components are normalized linear functions of causal variables, whose sum of squares of coefficients is equal to one. The first principal component has the largest variance equal to λ_1, the second has variance equal to λ_2 which is second to the largest, and so on. We have $\lambda_1 > \lambda_2 > ... > \lambda_K$.

All K principal components of K causal variables together account for the total variation among all causal variables. Generally, first few principal components account for a substantial part of total variation in all causal variables.

It should also be noted that the successive principal components are mutually orthogonal.

In order to compute the principal components, first of all obtain the variance–covariance matrix Σ of all causal variables. (If the units of measurements of different causal variables are not the same, we transform them to their standardized form and then obtain the variance–covariance matrix of the standardized causal variables. In other words, we obtain the correlation matrix R of the causal variables).

Next obtain the characteristic roots of Σ or R by solving the determinantal equation

$$|\Sigma - \lambda I| = 0,$$

or

$$|R - \lambda I| = 0.$$

This is a polynomial equation of degree K in λ. Therefore, it will provide K roots (or K values of λ) which are called the characteristic roots, or the latent roots or the eigen values of Σ or R. The K roots may be all distinct and real, or, they may be complex conjugates, or, repeated roots. In our present analysis we assume that the roots are distinct and real. Let us arrange the roots in descending order of magnitude as

$$\lambda_1 > \lambda_2 > \ldots > \lambda_K,$$

so that λ_1 is the largest root, λ_2 is the second largest and so on.

Corresponding to each value of λ solve the matrix equation

$$(\Sigma - \lambda I)\,\alpha = 0$$

or

$$(R - \lambda I)\,\alpha = 0$$

for the K x 1 vector α; such that $\alpha'\alpha = 1$.

Let $\alpha = \alpha^{(1)}$, corresponding to $\lambda = \lambda_1$; $\alpha = \alpha^{(2)}$ corresponding to $\lambda = \lambda_2$, and so on. Thus $\alpha^{(1)}$, $\alpha^{(2)}$, ..., $\alpha^{(K)}$ are successive characteristic vectors of Σ.

Then $P_1 = \alpha^{(1)'}x$, $P_2 = \alpha^{(2)'}x$, ... are the successive principal components, where $x' = (x_1, ..., x_K)$ is the vector of causal variables.

Since $V(P_1) = \lambda_1$, $V(P_2) = \lambda_2$, ... and $\sum_{k=1}^{K} \lambda_k$ is the total variance of all causal variables;

$\lambda_1 / \sum_{k=1}^{K} \lambda_k$ is the proportion of variance of all causal variables that is accounted for by the first principal component P_1; $\lambda_2 / \sum_{k=1}^{K} \lambda_k$ is the proportion of variation accounted for by P_2, and so on.

Let x_{1j}, ..., x_{Kj} be the j–th (j=1, ..., N) observation on the causal variables and

$$\alpha^{(1)} = \begin{pmatrix} \alpha_1^{(1)} \\ \vdots \\ \alpha_K^{(1)} \end{pmatrix}, \quad \alpha^{(2)} = \begin{pmatrix} \alpha_1^{(2)} \\ \vdots \\ \alpha_K^{(2)} \end{pmatrix}, \quad \ldots, \quad \alpha^{(K)} = \begin{pmatrix} \alpha_1^{(K)} \\ \vdots \\ \alpha_K^{(K)} \end{pmatrix}$$

be the successive characteristic vectors (obtained above) of Σ, or, of R; we may write

$$P_{1j} = \alpha_1^{(1)} x_{1j} + \ldots + \alpha_K^{(1)} x_{Kj}$$

...

$$P_{Kj} = \alpha_1^{(K)} x_{1j} + \ldots + \alpha_K^{(K)} x_{Kj}$$

for the j–th observation on successive principal components; j=1, ..., N. Therefore, the j–th observation on H* is given by

$$(\sum_{k=1}^{K} \lambda_k)\, H_j^* = \lambda_1 P_{1j} + \ldots + \lambda_K P_{Kj}$$

We may also express

$$(\sum_{k=1}^{K} \lambda_k) H^*_j =$$
$$[\lambda_1 \alpha_1^{(1)} + \ldots + \lambda_K \alpha_1^{(K)}]\, x_{1j} + \ldots + [\lambda_1 \alpha_K^{(1)} + \ldots + \lambda_K \alpha_K^{(K)}] x_{Kj}.$$

Thus the coefficient of x_{kj}

$$\frac{\lambda_1 \alpha_k^{(1)} + \ldots + \lambda_K \alpha_k^{(K)}}{\lambda_1 + \ldots + \lambda_K}$$

for k = 1, ..., K and j=1, ..., N provides the contribution that x_k makes in the value of H*.

APPENDIX OF CHAPTER IX

PRINCIPAL COMPONENT ANALYSIS

Suppose

$$(B.1) \qquad x = \begin{pmatrix} x_1 \\ \vdots \\ x_K \end{pmatrix}$$

is a K x 1 vector of random variables $x_1, ..., x_K$, which have zero means, E $x_k = 0$, and variances and covariances as given by E $x_k x_{k'} = \sigma_{kk'}$ for k, k' =1, ..., K.

We write

$$(B.2) \quad E\, xx' = \Sigma \equiv ((\sigma_{kk'}))$$

for the K x K covariance matrix of x's.

We seek to replace the set of random variables $x_1, ..., x_K$ by a set of smaller number of normalized linear functions of $x_1, ..., x_K$ which may explain major part of the total variation in all x's.

The normalized linear functions so obtained are called the 'principal components' of $x_1, ..., x_K$.

A linear function of $x_1, ..., x_K$ may be written as

$$(B.3) \quad z = \alpha' x = \alpha_1 x_1 + ... \alpha_K x_K$$

where

(B.4) $$\alpha = \begin{pmatrix} \alpha_1 \\ \vdots \\ \alpha_K \end{pmatrix}$$

is a K x 1 vector of coefficients.

Since $Ex=0$ and $Exx'=\Sigma$,

we have

$$Ez = 0 \quad \text{and}$$

(B.5)

$$Vz = E(\alpha'x)^2 = \alpha'\Sigma\alpha$$

as the mean and variance of z.

We should determine the coefficients $\alpha_1, \ldots, \alpha_K$ such that the variance of z is maximum, subject to the normalization restriction

(B.6) $$\alpha'\alpha = \sum_{k=1}^{K} \alpha_k^2 = 1.$$

Therefore, we formulate the Lagrangean function

(B.7) $$U = \alpha'\Sigma\alpha - \lambda(\alpha'\alpha - 1)$$

where λ is the Lagrangean multiplier; and determine α and λ such that U is maximum.

According to the principle of maxima and minima, we differentiate U partially with respect to the elements of α and λ and equate to zero, so that

$$(B.8) \qquad \frac{\partial U}{\partial \alpha} = 2\Sigma\alpha - 2\lambda\alpha = 0$$

and

$$(B.9) \qquad \frac{\partial U}{\partial \lambda} = \alpha'\alpha - 1 = 0,$$

are the first order conditions for a maximum, or, a minimum of U. It can be shown that the second order condition for the maximum of U is satisfied by the solution of (B.8) and (B.9).

The equation (B.8) implies

$$(B.10) \qquad (\Sigma - \lambda I)\,\alpha = 0$$

and (B.9) is, in fact, the normalization restriction. The equation (B.10) implies a set of K linear homogeneous equations in K unknown elements of α. Using (B.9) we can solve (B.10) for α in terms of a given value of λ, if the matrix $(\Sigma - \lambda I)$ is singular; i.e.

$$(B.11) \qquad |\Sigma - \lambda I| = 0.$$

The determinantal equation (B.11) is a polynomial equation of degree K in λ; and will, therefore, provide K values of λ, or, (B.11) has K roots (called the characteristic roots, or, the latent roots or eigen values of Σ). Theoretically, the roots of (B.11) may be all real and distinct, or, there may be some repeated roots, or, they be complex conjugates. However, in the present analysis we assume that all roots are distinct and real.

Arranging the roots of (B.11) is descending order of magnitude, we may write them as

(B.12) $\lambda_1 > \lambda_2 \ldots > \lambda_K$,

so that λ_1 is the largest root, λ_2 is the second largest and so on.

Corresponding to each root of (B.11) we can solve (B.10) for α, subject to $\alpha'\alpha = 1$. These are called the characteristic vectors, or, latent vectors or eigen vectors of Σ.

In order to see which root of (B.11) we should choose, let us premultiply (B.10) by α' and observe that

(B.13) $\alpha'\Sigma\ \alpha = \lambda\ \alpha'\alpha = \lambda$

as $\alpha'\alpha = 1$. Thus λ is, in fact, the variance of z which is to be maximized. Therefore, we choose the largest value λ_1 of λ and solve (B.10) for α subject to the restriction that $\alpha'\alpha = 1$. Let us write the solution as $\alpha^{(1)}$ and obtain

(B.14) $z_1 = \alpha^{(1)'} x$

as the first principal component. The variance of z_1 is

(B.15) $\lambda_1 = \alpha^{(1)'} \Sigma\ \alpha^{(1)}$.

Next, we obtain the normalized linear function $z = \alpha'x$ which has maximum variance in the class of all normalized linear functions **uncorrelated** with the first principal component. That is, we require

(B.16) $E\ zz_1 = E\ (\alpha'x)\ (\alpha^{(1)'}x) = \alpha'\Sigma\ \alpha^{(1)} = 0$.

Since $\Sigma\, \alpha^{(1)} = \lambda_1\, \alpha^{(1)}$, as $\alpha^{(1)}$ is the solution of (B.10) corresponding to $\lambda = \lambda_1$, (B.16) implies

(B.17) $\alpha' \Sigma\, \alpha^{(1)} = \lambda_1\, (\alpha' \alpha^{(1)}) = 0$

or

(B.18) $\alpha' \alpha^{(1)} = 0;$

i.e. the normalized linear functions in this class are orthogonal to $z_1 = \alpha^{(1)'} x$.

Now to obtain the second principal component, we formulate the Lagrangean function

(B.19) $U^* = \alpha' \Sigma\, \alpha - \lambda\, (\alpha' \alpha - 1) - 2\, \mu\, \alpha' \Sigma\, \alpha^{(1)}$

where λ and μ are Lagrangean multipliers, and maximize U^* with respect to α.

Partially differentiating U^* with respect to α and equating to zero, we get

(B.20) $2\Sigma\alpha - 2\lambda\alpha - 2\mu\, \Sigma\, \alpha^{(1)} = 0$

or

(B.21) $\Sigma\alpha - \lambda\alpha - \mu\, \Sigma\, \alpha^{(1)} = 0.$

Premultiplying (B.21) by $\alpha^{(1)'}$, we get

(B.22) $\alpha^{(1)'}\, \Sigma\, \alpha - \lambda\, \alpha^{(1)'} \alpha - \mu\, \alpha^{(1)'}\, \Sigma\, \alpha^{(1)} = 0;$

and using (B.17) and (B.18)

(B.23) $\mu\, (\alpha^{(1)'}\, \Sigma\, \alpha^{(1)}) = 0.$

Since $\alpha^{(1)'} \Sigma \alpha^{(1)} = V z_1 > 0$, we must have

(B.24) $\mu = 0$.

Therefore, from (B.21)

(B.25) $\Sigma \alpha - \lambda \alpha = 0$;

and, as before, λ should be chosen as the largest root of Σ, and we determine the corresponding α by solving the equation $(\Sigma - \lambda I) \alpha = 0$.

We choose the second largest root λ_2 and corresponding $\alpha^{(2)}$ to get the second principal component

(B.26) $z_2 = \alpha^{(2)'}x$

which has the variance

(B.27) $V(z_2) = \alpha^{(2)'} \Sigma \alpha^{(2)} = \lambda_2$,

and is orthogonal to z_1.

The process is continued till we obtain the K–th principal component $z_K = \alpha^{(K)'}x$ where $\alpha^{(K)}$ is the characteristic vector of Σ corresponding to the K–th root of Σ.

We note that

i We can compute as many principal components as the number of random variables

ii If we compute as many principal components as the number of random variables, the total variation in all random variables is explained by the principal components

iii The Principal components are mutually orthogonal,

iv The first few principal components themselves account for a substantial proportion of total variation in all random variables

v In practice, a set of K random variables may be adequately replaced by fewer number of principal components.

CHAPTER X

COMPUTATION OF THE PRINCIPAL COMPONENTS OF THE STANDARDIZED CAUSAL VARIABLES FOR 1971, 1981 AND 1991

It is postulated that the health status index (H*) for a given state is linearly determined by its

i **Enrolment Ratio at the Level of Middle School Education (LED),**

ii **Per Capita Expenditure on Health (PHE),**

iii **Per Capita Consumption Expenditure (PCE),**

iv **GINI Coefficient (GC) of the Inequality of Consumption Expenditure,**

v **Population Per Primary Health Centre (PPP),**

vi **Population Per Doctor (PPD), and**

vii **Percentage of Population Above Sixty Years of Age (PPO).**

The state–wise aggregative data on these causal variables for 1971, 1981 and 1991 are given in Table 1, 2 and 3, respectively.

The Table 4 provides matrices of correlations between the causal variables for successive census years.

Table 1

STATEWISE DATA ON CAUSAL VARIABLES: 1971

State	LED (%)	PHE (Rs per month)	PCE (Rs per month)	GC (Ratio)	PPP (No.)	PPD (No.)	PPO (%)
Andhra Pradesh	23.6	6.32	53.8	0.28	104403	4425	6.37
Assam	21.5	5.46	50.2	0.19	149980	2790	4.72
Bihar	20.1	3.28	46.8	0.24	95843	5975	5.90
Gujarat	36.1	7.01	58.8	0.31	106131	5627	5.26
Haryana	40.3	8.88	83.5	0.29	112502	6088	5.79
Karnataka	32.1	5.07	56.6	0.28	110358	4836	6.32
Kerala	69.8	7.17	51.5	0.31	131512	5369	6.22
Madhya Pradesh	25.8	4.89	51.5	0.31	93197	10656	5.79
Maharashtra	36.1	7.49	45.7	0.32	129662	2941	5.72
Orissa	21.9	4.85	47.9	0.32	70015	7989	6.02
Punjab	47.1	7.24	88.9	0.32	106519	2804	7.48
Rajasthan	26.2	8.84	69.3	0.32	110827	9003	5.51
Tamil Nadu	47.9	8.29	50.9	0.28	108517	2186	5.74
Uttar Pradesh	30.8	3.10	53.3	0.28	108493	8234	6.77
West Bengal	30.6	6.72	42.0	0.31	185810	1954	5.30

Table 2

STATEWISE DATA ON CAUSAL VARIABLES: 1981

State	LED (%)	PHE (Rs per month)	PCE(Rs per month)	GC (Ratio)	PPP (No.)	PPD (No.)	PPO (%)
Andhra Pradesh	27.9	22.51	75.9	0.30	127499	2037	6.65
Assam	21.2	19.38	57.4	0.20	136279	11879	4.94
Bihar	23.5	14.49	45.3	0.26	119105	4746	6.80
Gujarat	45.9	26.71	72.6	0.26	135799	3976	5.95
Haryana	45.6	37.10	83.0	0.28	145197	6133	6.34
Karnataka	38.3	21.00	65.3	0.30	130750	10577	6.62
Kerala	91.4	35.61	73.0	0.33	156157	6470	7.50
Madhya Pradesh	29.7	23.05	59.5	0.30	112212	3749	6.45
Maharashtra	44.8	33.26	61.0	0.29	146691	1798	6.38
Orissa	27.4	22.18	52.8	0.27	72445	6895	6.39
Punjab	59.6	32.55	93.2	0.29	13705	5216	7.80
Rajasthan	27.3	37.22	81.3	0.34	147680	11273	6.03
Tamil Nadu	51.5	30.10	56.7	0.33	96328	7470	6.41
Uttar Pradesh	28.5	14.38	60.1	0.29	122229	4096	6.84
West Bengal	30.5	27.78	46.9	0.29	50537	2115	5.55

Table 3

STATEWISE DATA ON CAUSAL VARIABLES: 1991

State	LED (%)	PHE(Rs per month)	PCE (Rs per month)	GC (Ratio)	PPP (No.)	PPD (No.)	PPO (%)
Andhra Pradesh	49.2	52.73	51.3	0.33	51813	2268	6.78
Assam	31.6	65.71	57.8	0.28	50761	2272	5.33
Bihar	32.9	27.95	42.3	0.28	43103	3682	6.26
Gujarat	67.7	70.19	49.1	0.26	58479	2147	6.39
Haryana	68.6	65.29	61.1	0.29	44643	5829	7.70
Karnataka	67.0	49.27	46.5	0.31	39526	1677	6.99
Kerala	101.0	58.68	58.3	0.36	32787	1865	8.82
Madhya Pradesh	55.0	56.53	47.3	0.31	55866	7758	6.32
Maharashtra	81.6	69.62	54.6	0.34	47847	1919	7.02
Orissa	50.0	44.51	45.8	0.30	34129	3194	7.20
Punjab	65.6	69.30	68.2	0.29	9921	820	7.84
Rajasthan	46.2	88.43	49.2	0.32	41841	3779	6.29
Tamil Nadu	103.0	58.95	47.1	0.34	40161	1390	7.45
Uttar Pradesh	46.6	33.42	46.4	0.30	44843	4733	6.86
West Bengal	53.1	44.59	52.8	0.30	44248	1755	6.10

SOURCES OF DATA

DATA ON CAUSES OF HEALTH STATUS

LEVEL OF EDUCATION (LED) – MIDDLE SCHOOL We refer to " A Dynamic Profile of Child labour in India 1951–1991. Child Labour Action and Support Project, ILO, New Delhi", by D. P. Chaudhri.

LED is the gross enrolment ratio in the middle school.

This has been calculated by using the following formula:

$$\frac{\text{Number of students enrolled in the middle school}}{\text{Population in the relevant age group}} \times 100$$

We observe from Tables 1, 2 and 3 that the percentage enrolment ratio sometimes exceeds 100. This is because in the Indian states it is difficult to find out age–wise enrolment in the middle (or primary) schools. Thus sometimes the number of students enrolled in the middle school exceeds the total population in the relevant age group.
(This method of finding the enrolment ratio has been used in IIIrd (1973), IV (1978) and VI (1993) Educational Survey of India by NCERT, New Delhi.

Per capita Expenditure on Health (PHE):– Per capita expenditure on health for the year 1971 is the figure for the year 1971–72 at current prices; for the year 1981 it is for the year 1981–82 at the current prices; and for the year 1991 it is for the year 1987–88 at current prices.

These data have been taken from **Health Information of India** (1971, 1981, 1991) published by Central Bureau of Health Information (C.B.H.I.), Director General of Health Services, Government of India.

Per capita Consumption Expenditure (PCE):– PCE for the year 1971 is the PCE for the year 1972–73 at 1973–74 prices, while PCE for the year 1981 is the PCE of the year 1983 at 1973–74 prices, and PCE for the year 1991 is the PCE of the year 1987–88 at 1970–71 prices.

We have used the monthly PCE figures in our analysis.

The data for 1971 and 1981 have been taken from Kakwani and Subbarao, "Rural Poverty and its Alleviation in India", **Economic and Political Weekly**, March 31, 1990, pp. A2–A16 of the appendix.

On the other hand the data for 1991 have been taken from Tendulkar, Sundaram and Jain (1993), "Poverty in India, 1970–71 to 1988–89", Working Paper of ILO – ARTEP, New Delhi, Table A5, based on the 43rd round of the NSS, 1987–88.

Gini Coefficient of Consumption Inequality (GC):– GC for the year 1971 is the GC of the year 1972–73, while GC for the year 1981 is the GC of the year 1983 and GC for the year 1991 is the GC of the year 1987–88.

The data for 1971 and 1981 have been taken from Kakwani and Subbarao, "Rural Poverty and its Alleviation in India", **Economic and Political Weekly**, March 31, 1990, pp. A2–A16 of the appendix.

On the other hand, the data for 1991 have been taken from Pal and Pant, "An Alternative Human Development Index", **Margin**, special issue, Jan–March 1993 Part II, Table A6, pp. 19 based on **Sarvekashana** Vol. XV, Issue No. 48, No. 1, 1991.

Population per Primary Health Centre (PPP):– The data for the year 1971, 1981 and 1991 have been taken from **Health Information of India**. (1971, 1981, 1991) published by Central Bureau of Health Information (C.B.H.I.), Director General of Health Services, Government of India.

Population Per Doctor (PPD):– The data for the year 1971, 1981 and 1991 have been taken from **Health Information of India**; (1971, 1981 and 1991) published by Central Bureau of Health Information (C.B.H.I.), Director General of Health Services, Government of India.

Proportion of Persons Over Sixty Years of Age (PPO):- The data on PPO have been obtained from

i **Census of India**, 1971, Series 1, Part II–C (ii), Social and Cultural Tables, Registrar General and Census Commissioner of India,

ii **Census of India**, 1981, Series 1, Part IV – A (IV), Social and Cultural Tables, and

iii **Census of India**, 1991, Series 1, Part IV, A – C Series, Vol. 1, Social and Cultural Tables.

(The census reports of 1971, 1981 and 1991, Social and Cultural Tables provide the age–wise population distribution. In order to calculate the percentage of population of age sixty years and more we add up the population of age group sixty and above. Then obtain the percentage with respect to the population of the state.)

Table 4

CORRELATION MATRICES OF CAUSAL VARIABLES

1971							
LED	1						
PHE	0.4860	1					
PCE	0.2648	0.4735	1				
GC	0.3522	0.4008	0.2278	1			
PPP	0.1758	0.2468	–0.2240	–0.1796	1		
PPD	–0.2922	–0.3129	0.0625	0.2431	–0.5981	1	
PPO	0.3131	–0.1794	0.4343	0.3465	–0.4087	0.0748	1
1981							
LED	1						
PHE	0.6071	1					
PCE	0.4427	0.6097	1				
GC	0.4461	0.5191	0.2916	1			
PPP	0.0377	0.0624	0.0394	0.0282	1		
PPD	–0.0626	0.0562	0.1254	–0.0759	0.2274	1	
PPO	0.5966	0.1406	0.4162	0.4980	–0.2150	–0.2561	1
1991							
LED	1						
PHE	0.2780	1					
PCE	0.2468	0.4970	1				
GC	0.6208	0.1319	0.0239	1			
PPP	–0.2364	–0.0350	–0.4943	–0.1432	1		
PPD	–0.3267	–0.1263	–0.2646	–0.1693	0.4177	1	
PPO	0.7536	0.0556	0.3919	0.5306	–0.5989	–0.1837	1

CHARACTERISTIC ROOTS AND VECTORS OF THE CORRELATION MATRICES OF OBSERVATIONS ON CAUSAL VARIABLES

As we observe from given data in Tables 1, 2 and 3 the units of measurement of causal variables are not the same. Therefore, we should, first of all, transform them to their standardized form before combining them into a linear from. That is, we subtract the arithmetic mean from each observation and divide by the standard deviation. Thus

$$x_{kj}^{**} = \frac{x_{kj} - \bar{x}_k}{s_{x_k}}$$

for k = 1, ..., K and j = 1, ..., N, where

$$\bar{x}_k = \frac{I}{N} \sum_{j=1}^{N} x_{kj} \text{ and } s_{x_k}^2 = \frac{I}{N} \sum_{j=1}^{N} (x_{kj} - \bar{x}_k)^2$$

provide the transformation of the matrix X of observations on the causal variables into

$X^{**} = ((x^{**}_{kj}))$.

In that case $R = (1/N)\, X^{**'}X^{**}$ is the correlation matrix of observations on the causal variables.

In order to compute the principal components of the causal variables, we should first compute the characteristic roots and vectors of the correlation matrices (given in Table 4) of the causal variables.

If R is the correlation matrix, the characteristic roots of R are obtained by solving the determinantal equation

$$| R - \lambda I | = 0.$$

For each of the years 1971, 1981 and 1991, R is a 7 x 7 matrix. Therefore, in each case, the determinantal equation is a seventh degree polynomial equation in λ; and will provide seven roots (values of λ) which are called the characteristic roots of R.

The characteristic vector α is obtained by solving the matrix equation

$$(R - \lambda I)\, \alpha = 0$$

corresponding to a given value of λ and subject to the normalization condition

$$\alpha'\alpha = 1.$$

The characteristic roots of the correlation matrices for 1971, 1981 and 1991 are given in Table 5 and the corresponding characteristic vectors are given in Tables 6, 7 and 8.

TABLE 5

CHARACTERISTIC ROOTS OF R

Year	λ						
1971	2.28560	2.08950	0.97664	0.81514	0.42677	0.34492	0.061352
1981	2.84150	1.44250	0.83971	0.68987	0.63365	0.47945	0.073335
1991	2.97550	1.35560	1.10410	0.81113	0.39344	0.28464	0.075586

TABLE 6

CHARACTERISTIC VECTORS CORRESPONDING TO SUCCESSIVE ROOTS OF R – 1971

Corresponding to						
λ_1=2.2856	λ_2=2.0895	λ_3=0.97664	λ_4=0.81514	λ_5=0.42677	λ_6=0.34492	λ_7=0.61352
α_1	α_2	α_3	α_4	α_5	α_6	α_7
–0.47341	–0.24255	–0.22377	0.33632	–0.70731	0.15637	–0.17069
–0.43633	–0.36430	0.44989	–0.22777	–0.03616	–0.27324	0.58877
–0.47918	0.10026	–0.03161	–0.70457	0.12371	0.30756	–0.39116
–0.45691	0.13807	0.37455	0.54847	0.46516	–0.07036	–0.33127
0.09896	–0.59681	–0.03873	0.13945	0.33889	0.69371	0.13037
0.03662	0.55688	0.45076	0.06670	–0.27367	0.56337	0.29772
–0.36876	0.33622	–0.63369	0.11777	0.27747	0.05220	0.50579

TABLE 7

CHARACTERISTIC VECTORS CORRESPONDING TO SUCCESSIVE ROOTS OF R 1981

Corresponding to						
λ_1=2.8415	λ_2=1.4425	λ_3=0.83971	λ_4=0.68987	λ_5=0.63365	λ_6=0.47945	λ_7=0.073335
α_1	α_2	α_3	α_4	α_5	α_6	α_7
0.49473	–0.00350	–0.09973	–0.10539	0.17541	–0.73169	0.40993
0.45647	0.28359	0.11743	0.59628	–0.07544	–0.12934	–0.56520
0.42888	0.21858	0.38767	–0.01151	0.46089	0.53856	0.33970
0.43119	–0.04054	–0.31907	0.01526	–0.71670	0.32830	0.29824
–0.01367	0.56923	–0.73458	–0.15345	0.29426	0.12094	–0.10689
–0.05120	0.62562	0.42661	–0.50210	–0.37390	–0.15913	–0.08220
0.41738	–0.39335	–0.05065	–0.59777	0.10518	0.10061	–0.53850

TABLE 8

CHARACTERISTIC VECTORS CORRESPONDING TO SUCCESSIVE ROOTS OF R – 1991

Corresponding to						
λ_1=2.9755	λ_2=1.3556	λ_3=1.1041	λ_4=0.81113	λ_5=0.39349	λ_6=0.28464	λ_7=0.075586
α_1	α_2	α_3	α_4	α_5	α_6	α_7
0.46987	0.31917	–0.21615	0.08645	–0.55627	–0.09491	–0.55201
0.21815	–0.40500	–0.70872	0.08685	0.14881	–0.47538	0.17441
0.35260	–0.56048	–0.09583	–0.27448	–0.02836	0.67996	–0.11773
0.35293	0.51228	–0.22193	0.12368	0.68456	0.28037	–0.03517
–0.38675	0.25308	–0.53686	0.18902	–0.36657	0.45480	0.34815
–0.29693	0.20273	–0.28375	–0.84783	0.09059	–0.09749	–0.23172
0.49498	0.22888	0.15435	–0.37390	–0.23752	–0.08779	0.68910

PRINCIPAL COMPONENTS OF STANDARDIZED CAUSAL VARIABLES

The principal components of causal variables are their normalized linear combinations, where the coefficients are elements of successive characteristic vectors. In the present case the units of measurement of the causal variables are not the same. Therefore, combining them as such in a linear form will not be appropriate. We may combine them after expressing them in their standardized form, ie, subtracting their respective means and dividing them by their standard deviations.

The arithmetic means and standard deviations of observations on causal variables are given Table 9.

The values of principal components of the causal variables for 1971, 1981 and 1991 are given in Tables 10, 11, and 12.

The following provides an illustration of the method of calculation of principal components for 1971 data.

The first characteristic vector, for 1971 data, corresponding to the largest root 2.2856 of R is given in the first column of Table 6.

TABLE 9

ARITHMETIC MEANS AND STANDARD DEVIATIONS OF OBSERVATIONS ON CAUSAL VARIABLES (1971, 1981, AND 1991)

		1971	1981	1991
LED	AM	33.993	39.540	61.273
	SD	13.235	18.260	21.358
PHE	AM	6.307	26.488	57.013
	SD	1.822	7.680	15.602
PCE	AM	56.713	65.600	51.847
	SD	13.577	13.840	6.986
GC	AM	0.29	0.29	0.31
	SD	0.036	0.034	0.027
PPP	AM	114920	114170	42665
	SD	26704	40187	11561
PPD	AM	5391.8	5895.3	3005.9
	SD	2662.8	3270.9	1883.2
PPO	AM	5.927	6.443	6.890
	SD	0.663	0.697	0.850

Therefore, the first principal component of standardized causal variables for 1971 is calculated as

$$P_1 = -0.47341\left(\frac{LED - 33.993}{13.235}\right) - 0.43633\left(\frac{PHE - 6.307}{1.822}\right) - 0.47918\left(\frac{PCE - 56.713}{13.577}\right) - 0.45691\left(\frac{GC - 0.29}{0.0360}\right) + 0.09896\left(\frac{PPP - 114920}{26704}\right) + 0.03662\left(\frac{PPD - 5391.8}{2662.8}\right) - 0.36876\left(\frac{PPO - 5.927}{0.663}\right)$$

Using the second characteristic vector, for 1971 data, corresponding to the second largest root 2.0895 of R, from Table 6, we obtain the second principal component as

$$P_2 = -0.24255\left(\frac{LED - 33.993}{13.235}\right) - 0.36430\left(\frac{PHE - 6.307}{1.822}\right) + 0.10026\left(\frac{PCE - 56.713}{13.577}\right) + 0.13807\left(\frac{GC - 0.29}{0.036}\right) - 0.59681\left(\frac{PPP - 114920}{26704}\right) + 0.55688\left(\frac{PPD - 5391.8}{2662.8}\right) + 0.36622\left(\frac{PPO - 5.927}{0.663}\right)$$

Similarly, other principal components have been calculated for 1971, 1981, 1991.

Values of principal components for different states are obtained by substituting the corresponding values of the causal variables.

TABLE 10

PRINCIPAL COMPONENTS OF STANDARDISED CAUSAL VARIABLES FOR 1971

States	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Andhra Pradesh	0.31090	0.38073	–0.49318	–0.27853	0.54004	–0.61302	0.49557
Assam	2.92619	–1.97759	–0.36658	–1.50642	–0.47145	0.29401	–0.04011
Bihar	2.16896	1.12596	–0.86380	–0.32329	–0.25736	–0.20997	–0.09625
Gujarat	–0.22150	–0.18195	1.02421	–0.00613	–0.27215	–0.30209	–0.56357
Haryana	–1.70148	–0.30486	0.71209	–1.58128	–0.31251	0.37047	–0.05445
Karnataka	0.26014	0.42560	–0.84810	–0.01818	0.15059	–0.02360	–0.05797
Kerala	–1.65065	–1.02017	–0.48643	1.50554	–1.39276	0.58699	0.09071
Madhya Pradesh	0.64140	1.98390	1.06001	0.52770	–0.20735	0.49812	–0.00572
Maharashtra	–0.20631	–1.19104	0.34976	0.90340	0.49518	–0.61125	0.04164
Orissa	0.53711	2.15474	0.58611	0.62687	0.17674	–0.79105	–0.18881
Punjab	–3.13311	0.35926	–1.67372	–0.83868	0.76433	0.04348	–0.20856
Rajasthan	–0.88079	0.47946	2.04504	–0.72458	0.26463	0.38104	0.35502
Tamil Nadu	–0.59610	–1.35664	–0.19923	0.09771	–0.80304	–1.10303	0.19589
Uttar Pradesh	0.68656	1.79751	–1.15336	0.52094	0.04291	0.88732	0.12844
West Bengal	0.85901	–2.67482	0.30722	1.09373	1.28071	0.59194	–0.09196

TABLE 11

PRINCIPAL COMPONENTS OF THE STANDARDISED CAUSAL VARIABLES FOR 1981

States	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Andhra Pradesh	0.02923	–0.65314	–0.31533	0.12093	0.69802	1.25595	0.24854
Assam	–3.30220	2.02290	1.29991	–0.19392	0.74691	–0.76480	0.08105
Bihar	–1.89823	–1.07986	–0.45178	–0.98475	0.09565	–0.09112	–0.48085
Gujarat	–0.22196	0.36739	0.03363	0.59587	1.18184	–0.16723	0.42482
Haryana	1.15391	1.21981	0.38186	0.70664	0.88793	0.24399	–0.29551
Karnataka	–0.19383	0.80884	0.31774	–1.34808	–0.60020	0.09063	0.17149
Kerala	3.31050	0.50136	–0.87501	–0.73590	0.18767	–1.29436	0.09151
Madhya Pradesh	–0.47627	–0.67528	–0.30539	0.13445	–0.27772	0.42616	0.04121
Maharashtra	0.44280	–0.11554	–0.97739	1.05530	0.49102	–0.19797	–0.41567
Orissa	–1.24296	–0.70691	0.92521	–0.20975	–0.55014	–0.29437	–0.29964
Punjab	2.63736	–1.66347	2.60682	–0.34085	0.56124	0.11143	–0.06478
Rajasthan	1.09614	2.32348	0.52826	0.31675	–1.20909	1.19316	–0.13427
Tamil Nadu	0.74924	0.00670	0.10531	0.08934	–1.40108	–0.62298	0.17680
Uttar Pradesh	–0.90421	–0.98735	–0.48843	–0.96504	0.11673	0.61834	0.24174
West Bengal	–1.17925	–1.36824	0.48156	1.75827	–0.92830	–0.50660	0.21301

TABLE 12

PRINCIPAL COMPONENTS OF STANDARDISED CAUSAL VARIABLES FOR 1991

States	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Andhra Pradesh	–1.30926	0.49915	–0.19536	0.58318	0.55866	0.77796	0.52048
Assam	–1.65329	–1.98966	–0.49863	0.71719	0.27850	0.67879	–0.13062
Bihar	–2.35896	0.48649	1.72535	–0.04731	–0.00115	–0.15729	0.02513
Gujarat	–1.11964	–0.80972	–0.93089	0.85444	–1.64020	–0.47375	0.26630
Haryana	0.47654	–0.61342	–0.80448	–1.96242	0.74435	0.28269	0.13864
Karnataka	0.15610	0.58089	0.70784	0.70563	–0.12528	–0.34804	0.00241
Kerala	3.54939	1.21744	–0.02159	–0.33727	0.01723	0.42135	0.22134
Madhya Pradesh	–1.86229	0.98246	–1.30541	–1.51024	0.21426	–0.03905	–0.41959
Maharashtra	1.26525	0.41087	–1.13854	0.71155	0.15947	0.38196	–0.07870
Orissa	–0.38818	0.41851	1.25034	–0.27201	0.20504	–0.61132	0.23402
Punjab	2.85768	–2.59338	1.33932	–0.60544	0.16400	–0.25584	–0.17459
Rajasthan	–0.30846	–0.67418	–1.52738	0.18231	1.25703	–1.03494	0.16396
Tamil Nadu	1.80011	1.49812	–0.25605	0.95727	–0.37041	–0.43957	–0.44179
Uttar Pradesh	–1.38689	0.91640	0.98961	–0.73932	0.01458	0.17731	0.04543
West Bengal	–0.71720	–0.32888	0.66565	0.76303	0.01403	0.63935	–0.37261

CHAPTER XI

COMPUTATION OF HEALTH STATUS INDEX FOR FIFTEEN STATES OF INDIA FOR 1971, 1981 AND 1991

Seven principal components of standardized causal variables LED, PHE, PCE, GC, PPP, PPD and PPO have been calculated in the preceding chapter and their values for 15 states have been given in Tables 10, 11, and 12 for 1971, 1981 and 1991, respectively.

The variance of successive principal components, proportion of total variation explained by them and cumulative proportion of variation explained is given in Table 13.

It should be noted that the cumulative proportion of variation explained by all seven principal components is 100%.

The first principal component for 1971 data, for example, accounts for 32.65% of the total variation in all seven causal variables, the first and second principal components, together, account for 62.50%, the first three account for 76.45%, the first four account for 88.09%, the first five account for 94.19%, the first six account for 99.12% and all seven principal components account for 100% of total variation in all seven causal variables. Similarly for other years 1981 and 1991.

As suggested in the preceding chapter, we compute the 'community health status index' for each state as a weighted average

$$H^* = \frac{\lambda_1 P_1 + \ldots + \lambda_K P_K}{\lambda_1 + \ldots + \lambda_K}$$

of principal components of the causal variables, where weights are variances of successive principal components.

TABLE 13

PROPORTION OF VARIATION ACCOUNTED FOR BY SUCCESSIVE PRINCIPAL COMPONENTS

Variance of P_k k=1, ---, 7			Proportion of Variance Accounted			Cumulative Proportion of Variance Accounted		
λ_k			$\lambda_k/\Sigma\lambda_k$					
1971	1981	1991	1971	1981	1991	1971	1981	1991
2.2856	2.8415	2.9755	0.3265	0.4059	0.4251	0.3265	0.4059	0.4251
2.0895	1.4425	1.3556	0.2985	0.2061	0.1937	0.6250	0.6120	0.6188
0.9766	0.8397	1.1041	0.1395	0.1200	0.1577	0.7645	0.7320	0.7765
0.8151	0.6899	0.8111	0.1164	0.0986	0.1159	0.8809	0.8306	0.8924
0.4268	0.6337	0.3934	0.0610	0.0905	0.0562	0.9419	0.9210	0.9486
0.3449	0.4795	0.2846	0.0493	0.0685	0.0407	0.9912	0.9895	0.9892
0.0615	0.0732	0.0757	0.0088	0.0105	0.0108	1.0000	1.0000	1.0000

TABLE 14

STATEWISE HEALTH STATUS INDICES

States	1971		1981		1991	
	H*	Rank	H*	Rank	H*	Rank
Andhra Pradesh	0.1209809	(6)	0.003177338	(8)	0.07062609	(7)
Assam	0.1239607	(5)	–0.7706924	(14)	–1.041778	(15)
Bihar	0.8592606	(3)	–1.146937	(15)	–0.6480498	(12)
Gujarat	–0.02086751	(9)	0.1483447	(7)	–0.7891322	(13)
Haryana	–0.7326293	(13)	0.9292109	(4)	–0.2993613	(9)
Karnataka	0.09904897	(7)	–0.05307243	(9)	0.3510922	(5)
Kerala	–0.7912353	(14)	1.198941	(1)	1.722518	(1)
Madhya Pradesh	1.022828	(1)	–0.3513890	(10)	–0.9763211	(14)
Maharashtra	–0.2684581	(11)	0.1692252	(5)	0.5439044	(4)
Orissa	0.943490	(2)	–0.6330090	(11)	0.07093266	(6)
Punjab	–1.200047	(15)	1.064661	(2)	0.8505118	(3)
Rajasthan	0.0944965	(8)	0.9892084	(3)	–0.4511266	(11)
Tamil Nadu	–0.7176109	(12)	0.1593107	(6)	1.082369	(2)
Uttar Pradesh	0.7079444	(4)	–0.6687567	(13)	–0.3331211	(10)
West Bengal	–0.2412887	(10)	–0.6460907	(12)	–0.1523772	(8)

The state–wise health status indices, $\hat{H}^*$, are given in Table 14.

Value of the health status index, of any state and in any particular year, reflects the composite effect of changes in the causal variables.

We should, generally, expect that the health status of a state should rise if LED and PHE increase and if PPP, PPD and PPO decrease. The per capita consumption expenditure (PCE) is a proxy for per capita income of the state. This reflects the economic level of the state. However, an increase or decrease in PCE alone is not adequate for a corresponding rise or fall in the value of H*. The inequality in the distribution of consumption expenditure in the state, as measured by the GINI coefficient (GC), should have a crucial effect on H*. In other words, a high value of PCE coupled with a low value of GC should indicate a high value of H*. A high value of PCE and a high value of GC may not correspond with a high value of H*.

We observe, from Table 14, that $\hat{H}^*$ has consistently increased over the years 1971, 1981, and 1991 for Kerala, Maharashtra and Tamil Nadu; where as it has consistently decreased over these years for Assam and Madhya Pradesh. Let us look at the data on causal variables for these states.

The Tables 15–21 give the ranks of different states by magnitudes of the causal variables LED, PHE, PCE, GC, PPP, PPD, and PPO.

Kerala, Maharashtra and Tamil Nadu had relatively high ranks among all states according to the level of education (upto middle school). Kerala had the rank 1 in 1971 and 1981 and rank 2 in 1991. Tamil Nadu had rank 1 in 1991 and ranks 2 and 3 in 1971 and 1981, respectively. Maharashtra had rank 3 in 1991 but ranks 6 in 1971 and 1981.

The per capita expenditure on health (PHE) was relatively lower in Kerala and Tamil Nadu among all states. Maharashtra had high rank 3 in 1991 and rank 4 in 1971 and 1981, where as Kerala had ranks 6, 3 and 8, and Tamil Nadu had ranks 3, 6 and 7 in 1971, 1981 and 1991, respectively.

Although Kerala had been improving its position over years with respect to PCE (per capita expenditure on consumption), it had high and growing inequality in the distribution of consumption expenditure, as measured by the GINI Coefficient (GC).

According to PCE Kerala had ranks 8, 5 and 3 and GC had values 0.31, 0.33 and 0.36 in 1971, 1981 and 1991, respectively. These values of GC are close to the highest in all states. Maharashtra and Tamil Nadu show a similar picture. Although the ranks of both states with respect to PCE improved over years (14, 8, 5 for Maharashtra and 10, 12, 11 for Tamil Nadu in 1971, 1981 and 1991, respectively), the inequality in the distribution of consumption expenditure was high and it increased over years. In Tamil Nadu GC was 0.28 in 1971, 0.33 in 1981 and 0.34 in 1991; and in Maharashtra GC was equal to 0.32 in 1971, 0.29 in 1981 and 0.34 in 1991.

The proportion of persons per primary health centre (PPP) and per doctor (PPD) in Kerala had higher ranks in 1991 than in 1971 and 1981. The number of persons per primary health centre in Kerala was 131512 which was the third highest in 1971. It increased to 156157 (the highest among all states) in 1981, and reduced to 32787 in 1991. Similarly the PPD in Kerala was 5369, 6470 and 1865 in 1971, 1981 and 1991, respectively. With respect to PPP and PPD the situation in Maharashtra was similar to that in Kerala. The number of persons per primary health centre in Maharashtra was 129662, 146691 and 47847 in 1971, 1981 and 1991, respectively; and PPD was 2941, 1798 and 1919 in 1971, 1981 and 1991. Tamil Nadu had PPP as 108517, 96328 and 40161 in 1971, 1981 and 1991, respectively and PPD as 2186, 7470 and 1390.

Thus Kerala, Maharashtra and Tamil Nadu had better health care availability per person in 1991 than in 1971 and 1981.

The accompanying Table 21 gives the proportion of persons above 60 years of age in Kerala, Maharashtra and Tamil Nadu over the years 1971, 1981 and 1991.

We observe that these states had increasing proportion of persons above 60 years of age.

Among all states, Kerala had the highest proportion (8.82%) of persons above sixty years in 1991. The proportion (7.50%) in 1981 was the second highest and it was the fifth highest in 1971.

Maharashtra was the sixth highest in 1991 (with 7.02% persons above 60 years), tenth highest in 1981 (with 6.38%) and eleventh highest in 1971 (with 5.72%).

Tamil Nadu had the fourth highest position in 1991, 8th in 1981 and 10th in 1971.

Increasing proportion of old people in the population indicates lower mortality but higher morbidity.

To sum up, let us observe that where as Kerala, Maharashtra and Tamil Nadu showed general improvement in the health status among all states over the years, they also showed growing inequality in per capita consumption expenditure and increase in the proportion of persons above 60 years of age.

Assam and Madhya Pradesh show a consistent decline in the health status over years. Their ranks according to the value of $\hat{H}^*$ were 5, 14, 15 and 1, 10, 14, among all states, in 1971, 1981 and 1991, respectively.

The ranks of these states according to the values of causal variables are shown in Tables 15–21.

Looking at the values of causal variables we find that Assam had the lowest proportion of persons, among all states, with education upto middle school (21.5% in 1971, 21.2% in 1981 and 31.6% in 1991). Although Assam improved its rank with respect to PHE and PCE in 1991 over that in 1981 (it was 5th highest in 1991 compared to 13th in 1981 with respect to PHE and 4th in 1991 compared to 11th in 1981 with respect to PCE) and GC was fairly low in 1991 (GC was equal to 0.28 in 1991 and lowest among all states in 1971 and 1981), the PPP and PPD were rather high. The PPO was lowest. This indicates high morbidity and mortality rates.

Madhya Pradesh had ranks 9 and 8 in 1981 and 1991, respectively, with respect to LED (where as 29.7% persons had education upto middle school in 1981, the proportion was 55.0% in 1991), rank 9 both in 1981 and 1991 with respect to PHE and rank 10 both in 1981 and 1991 with respect to PCE. The GC was 0.30 in 1981 and 0.31 in 1991. Thus ranks according to LED, PHE and PCE are lower and GC is on the high side. Madhya Pradesh had also large proportion of persons per primary health centre and per doctor. The situation in this respect deteriorated considerably in 1991 compared to 1981. The proportion of persons above sixty years in not too bad.

We observe from Table 14 that $\hat{H}^*$ for Punjab was the lowest in 1971 but it improved substantially in 1981 and 1991. $\hat{H}^*$ for Punjab was the second highest in 1981 and third in 1991 among all states.

Haryana had the 4th highest rank with respect to $\hat{H}^*$ in 1981 and 9th rank in 1991; and Rajasthan had 3rd rank in 1981 but it deteriorated to 11th rank in 1991.

Maharashtra had 5th rank in 1981 and 4th in 1991 with respect to $\hat{H}^*$.

Kerala had the highest ranks with respect to $\hat{H}^*$ in 1981 and 1991.

TABLE 15

RANKS OF STATES BY LED*

States	1971		1981		1991	
	LED (%)	Rank	LED (%)	Rank	LED (%)	Rank
Andhra Pradesh	23.6	12	27.9	13	49.2	11
Assam	21.5	14	21.2	15	31.6	15
Bihar	20.1	15	23.5	14	32.9	14
Gujarat	36.1	5	45.9	4	67.7	5
Haryana	40.3	4	45.6	5	68.6	4
Karnataka	32.1	7	38.3	7	67.0	6
Kerala	69.8	1	91.4	1	101.0#	2
Madhya Pradesh	25.8	11	29.7	9	55.0	8
Maharashtra	36.1	6	44.8	6	81.6	3
Orissa	21.9	13	27.4	11	50.0	10
Punjab	47.1	3	59.6	2	65.6	7
Rajasthan	26.2	10	27.3	12	46.2	13
Tamil Nadu	47.9	2	51.5	3	103.0#	1
Uttar Pradesh	30.8	8	28.5	10	46.6	12
West Bengal	30.6	9	30.5	8	53.1	9

* Level of Education upto Middle School is the gross enrolment ratio defined as "Number of students enrolled in the middle school" divided by "Population in relevant age group" multiplied by 100.

\# This exceeds 100 as it is difficult to find age-wise enrolment in the middle school. Sometimes the number of students enrolled exceeds the total population in the relevant age-group.

TABLE 16

RANKS OF STATES BY PHE*

States	1971		1981		1991	
	PHE (Rs per month)	Rank	PHE (Rs per month)	Rank	PHE (Rs per month)	Rank
Andhra Pradesh	6.32	9	22.51	10	52.73	10
Assam	5.46	10	19.38	13	65.71	5
Bihar	3.28	14	14.49	14	27.95	15
Gujarat	7.01	7	26.71	8	70.19	2
Haryana	8.88	1	37.10	2	65.29	6
Karnataka	5.07	11	21.00	12	49.27	11
Kerala	7.17	6	35.61	3	58.68	8
Madhya Pradesh	4.89	12	23.05	9	56.53	9
Maharashtra	7.49	4	33.26	4	69.62	3
Orissa	4.85	13	22.18	11	44.51	13
Punjab	7.24	5	32.55	5	69.30	4
Rajasthan	8.84	2	37.22	1	88.43	1
Tamil Nadu	8.29	3	30.10	6	58.95	7
Uttar Pradesh	3.10	15	14.38	15	33.42	14
West Bengal	6.72	8	27.78	7	44.59	12

* Per capita expenditure on health for the year 1971 is the figure for 1971–72 at current prices; for 1981 it is for the year 1981–82 at current prices; and for 1991 it is for the year 1987–88 at current prices.

TABLE 17

RANKS OF STATES BY PCE*

States	1971		1981		1991	
	PCE (Rs per month)	Rank	PCE (Rs per month)	Rank	PCE (Rs per month)	Rank
Andhra Pradesh	53.8	6	75.9	4	51.3	7
Assam	50.2	11	57.4	11	57.8	4
Bihar	46.8	13	45.3	15	42.3	15
Gujarat	58.8	4	72.6	6	49.1	9
Haryana	83.5	2	83.0	2	61.1	2
Karnataka	56.6	5	65.3	7	46.5	12
Kerala	51.5	8	73.0	5	58.3	3
Madhya Pradesh	51.5	9	59.5	10	47.3	10
Maharashtra	45.7	14	61.0	8	54.6	5
Orissa	47.9	12	52.8	13	45.8	14
Punjab	88.9	1	93.2	1	68.2	1
Rajasthan	69.3	3	81.3	3	49.2	8
Tamil Nadu	50.9	10	56.7	12	47.1	11
Uttar Pradesh	53.3	7	60.1	9	46.4	13
West Bengal	42.0	15	46.9	14	52.8	6

* Per capita consumption expenditures for 1971 are for the year 1972–73 at 1973–74 prices; while those for 1981 are for 1983 at 1973–74 prices; and for 1991 are for the year 1987–88 at 1970–71.

Table 18

VALUES OF GC IN DIFFERENT STATES ARRANGED IN ASCENDING ORDER*

States	1971		States	1981		States	1991
Assam	0.19		Assam	0.20		Gujarat	0.26
Bihar	0.24		Bihar	0.26		Assam	0.28
Andhra Pradesh	0.28		Gujarat	0.26		Bihar	0.28
Karnataka	0.28		Orissa	0.27		Haryana	0.29
Tamil Nadu	0.28		Haryana	0.28		Punjab	0.29
Uttar Pradesh	0.28		Maharashtra	0.29		Orissa	0.30
Haryana	0.29		Punjab	0.29		Uttar Pradesh	0.30
Gujarat	0.31		Uttar Pradesh	0.29		West Bengal	0.30
Kerala	0.31		West Bengal	0.29		Karnataka	0.31
Madhya Pradesh	0.31		Andhra Pradesh	0.30		Madhya Pradesh	0.31
West Bengal	0.31		Karnataka	0.30		Rajasthan	0.32
Maharashtra	0.32		Madhya Pradesh	0.30		Andhra Pradesh	0.33
Orissa	0.32		Kerala	0.33		Maharashtra	0.34
Punjab	0.32		Tamil Nadu	0.33		Tamil Nadu	0.34
Rajasthan	0.32		Rajasthan	0.34		Kerala	0.36

* GINI coefficients for 1971 are of the year 1972–73; while those for 1981 are for 1983 and those for the year 1991 are of 1987–88.

TABLE 19

RANKS OF STATES BY PPP*

States	1971		1981		1991	
	PPP (Number)	Rank	PPP (Number)	Rank	PPP (Number)	Rank
Andhra Pradesh	104403	12	127499	8	51813	3
Assam	149980	2	136279	5	50761	4
Bihar	95843	13	119105	10	43103	9
Gujarat	106131	11	135799	6	58479	1
Haryana	112502	5	145197	4	44643	7
Karnataka	110358	7	130750	7	39526	12
Kerala	131512	3	156157	1	32787	14
Madhya Pradesh	93197	14	112212	11	55866	2
Maharashtra	129662	4	146691	3	47847	5
Orissa	70015	15	72445	13	34129	13
Punjab	106519	10	13705	15	9921	15
Rajasthan	110827	6	147680	2	41841	10
Tamil Nadu	108517	8	96328	12	40161	11
Uttar Pradesh	108493	9	122229	9	44843	6
West Bengal	185810	1	50537	14	44248	8

* Population per primary health centre is measured as "number of persons per primary health centre".

TABLE 20

RANKS OF STATES BY PPD*

States	1971		1981		1991	
	PPD (Number)	Rank	PPD (Number)	Rank	PPD (Number)	Rank
Andhra Pradesh	4425	10	2037	14	2268	8
Assam	2790	13	11879	1	2272	7
Bihar	5975	6	4746	9	3682	5
Gujarat	5627	7	3976	11	2147	9
Haryana	6088	5	6133	7	5829	2
Karnataka	4836	9	10577	3	1677	13
Kerala	5369	8	6470	6	1865	11
Madhya Pradesh	10656	1	3749	12	7758	1
Maharashtra	2941	11	1798	15	1919	10
Orissa	7989	4	6895	5	3194	6
Punjab	2804	12	5216	8	820	15
Rajasthan	9003	2	11273	2	3779	4
Tamil Nadu	2186	14	7470	4	1390	14
Uttar Pradesh	8234	3	4096	10	4733	3
West Bengal	1954	15	2115	13	1755	12

* Proportion of persons per doctor is measured as "number of persons per doctor".

TABLE 21

RANKS OF STATES BY PPO*

States	1971		1981		1991	
	PPO (%)	Rank	PPO (%)	Rank	PPO (%)	Rank
Andhra Pradesh	6.37	3	6.65	5	6.78	9
Assam	4.72	15	4.94	15	5.33	15
Bihar	5.90	7	6.80	4	6.26	13
Gujarat	5.26	14	5.95	13	6.39	10
Haryana	5.79	9	6.34	11	7.70	3
Karnataka	6.32	4	6.62	6	6.99	7
Kerala	6.22	5	7.50	2	8.82	1
Madhya Pradesh	5.79	9	6.45	7	6.32	11
Maharashtra	5.72	11	6.38	10	7.02	6
Orissa	6.02	6	6.39	9	7.20	5
Punjab	7.48	1	7.80	1	7.84	2
Rajasthan	5.51	12	6.03	12	6.29	12
Tamil Nadu	5.74	10	6.41	8	7.45	4
Uttar Pradesh	6.77	2	6.84	3	6.86	8
West Bengal	5.30	13	5.55	14	6.10	14

* Proportion of persons above sixty years of age as measured by "percentage of the total population of the state".

CHAPTER XII

RELATIONSHIP BETWEEN THE HEALTH STATUS OF THE STATE AND THE INDICATORS OF HEALTH

As mentioned earlier the most commonly used indicators of health in a state are

(i) the expectation of life at birth (LE)

(ii) the crude death rate (CDR), and

(iii) the infant mortality rate (IMR).

State–wise data on indicators and their ranks are given in Table 22, 23 and 24 for 1971, 1981 and 1991; and the health status indices for various states and the same years are given in Table 14 of the preceding chapter.

In order to evaluate the effect of changes in H* on any one of the indicator variables, we regress that indicator variable on H* and the regression is estimated by Ordinary Least Squares. The regression coefficients are given in the Table 25.

We should, generally, expect that an improvement in the health status of a state (i.e., an increase in the value of H*) should lead to an increase in the expectation of life at birth (LE). The coefficient of H* in the regression of LE on H* should be positive and significant. This is very well demonstrated by the results shown in the Table 25, for both the years 1981 and 1991. The coefficients of H* are positive and highly significant in both the years. The coefficient of H* turns out to be negative in 1971. However, it is insignificant and can, therefore, be taken to be zero. This is not expected to be so in theory. It may be due to inadequacy of data for that year.

Where as, we have regressed life expectancy on the health status index H*, we note that H* may depend on many other exogenous variables, which have not been included in the construction of H*. For example, the consumption habits of the people, their nutritional

intake, living and sanitary conditions and environmental variables affect the health status of the people. Moreover, the effectiveness of medical care facilities and available infrastructure are important determinants of the health status. Unfortunately, data on these variables in such detail are not available at the state level.

The crude death rate data pose a problem as they include deaths not only due to the health status of the state but also accidental deaths and deaths due to suicides, murders and other causes unrelated to the health status of the state. The estimated coefficient of H*, in the regression of CDR on H* turns out to be negative and highly significant for 1991; but the results are unsatisfactory for 1971 and 1981.

We should, generally, expect that an improvement in the health status of the state should lead to a decline in the infant mortality. It turns out that the results of regressing IMR on H* provide expected results for 1991 (as the coefficient of H* is negative and highly significant) but the results are unsatisfactory for 1971 and 1981. These unsatisfactory results may be because we have not taken into account the environmental factors. The malnutrition, poor living and sanitary conditions, lack of immunization and health care facilities may affect infant mortality more than a summary index of health status of the state.

In brief, where as the 1991 results are extremely satisfactory, we should emphasise the need to improve the specification of the model as follows:

(a) we may include more variables in the construction of H* (over and above those listed before, viz, LED, PHE, PCE, GC, PPP, PPD and PPO.)

(b) while regressing indicators on H*, we may include relevant exogenous variables also in addition to H*.

TABLE 22

RANKS OF STATES BY LE*

States	1971		1981		1991	
	LE (years)	Rank	LE (years)	Rank	LE (years)	Rank
Andhra Pradesh	44.4	11	55.7	7	62.9	6
Assam	46.0	7	48.8	14	58.6	12
Bihar	41.0	14	52.3	11	60.5	10
Gujarat	53.7	2	54.5	9	61.8	8
Haryana	50.6	3	58.6	3	64.7	4
Karnataka	44.6	10	58.5	4	64.7	4
Kerala	48.8	6	66.5	1	71.9	1
Madhya Pradesh	54.4	1	50.2	13	58.6	12
Maharashtra	54.4	1	58.1	5	64.9	3
Orissa	44.7	9	50.8	12	59.3	11
Punjab	43.8	12	62.8	2	66.6	2
Rajasthan	49.4	5	52.5	10	60.9	9
Tamil Nadu	49.6	4	55.9	6	63.0	5
Uttar Pradesh	43.0	13	46.8	15	55.1	13
West Bengal	44.9	8	55.1	8	62.0	7

* Expectation of life at birth is measured as "the number of years a child born is expected to live".

TABLE 23

RANKS OF STATES BY CDR*

States	1971		1981		1991	
	CDR (No. per 1000)	Rank	CDR (No. per 1000)	Rank	CDR (No. per 1000)	Rank
Andhra Pradesh	14.6	5	10.4	10	9.7	7
Assam	17.8	1	12.1	7	11.5	3
Bihar	14.2	7	13.0	4	9.8	6
Gujarat	16.4	2	11.6	9	8.5	10
Haryana	9.9	12	9.0	14	8.2	12
Karnataka	12.1	9	9.3	12	9.0	8
Kerala	9.9	12	6.7	15	6.0	14
Madhya Pradesh	15.6	3	14.5	2	13.8	1
Maharashtra	12.3	8	9.2	13	8.2	12
Orissa	15.5	4	12.5	6	12.8	2
Punjab	10.4	10	12.8	5	7.8	13
Rajasthan	15.6	3	13.7	3	10.1	5
Tamil Nadu	14.4	6	11.7	8	8.8	9
Uttar Pradesh	10.1	11	15.7	1	11.3	4
West Bengal	9.2	13	10.3	11	8.3	11

* Crude death rate is measured as 'total number of deaths, in a year, per 1,000 of population'.

TABLE 24

RANKS OF STATES BY IMR*

States	1971		1981		1991	
	IMR (No. per 1000)	Rank	IMR (No. per 1000)	Rank	IMR (No. per 1000)	Rank
Andhra Pradesh	100.65	8	75	12	73	7
Assam	108.20	7	97	7	81	4
Bihar	90.75	11	96	8	69	9
Gujarat	145.10	1	106	5	69	9
Haryana	71.75	14	102	6	68	10
Karnataka	87.10	13	74	13	77	6
Kerala	47.80	15	29	15	16	14
Madhya Pradesh	132.45	3	120	4	117	2
Maharashtra	96.40	9	76	11	60	11
Orissa	121.55	5	130	2	124	1
Punjab	95.10	10	66	14	53	13
Rajasthan	126.50	4	122	3	79	5
Tamil Nadu	111.90	6	78	10	57	12
Uttar Pradesh	137.8	2	154	1	97	3
West Bengal	87.2	12	82	9	71	8

* Infant mortality rate is measured as 'number of child deaths per 1000 of children below one year of age'.

TABLE 25

OLS ESTIMATED COEFFICIENTS OF H* IN LINEAR REGRESSIONS OF INDICATOR VARIABLES ON H*

Indicator Variables	1971	1981	1991
LE	−1.042	5.265***	3.912***
	(0.596)	(4.020)	(4.440)
CDR	1.980*	5.304	−1.688***
	(1.976)	(1.107)	(3.113)
IMR	21.181**	−18.541*	−21.479***
	(2.370)	(1.829)	(3.159)

N.B. The figures within brackets below the coefficient estimates are | t | – ratios. The 1% value of t on 13 degrees of freedom is 3.012, the 5% value of t on 13 d.f. is 2.160 and 10% value of t on 13 d.f. is 1.771. We put one star (*) if the value is significant on 10% level, two stars (**) if it is significant on 5% level and (***) if the value is significant on 1% level.

DATA ON INDICATORS OF HEALTH

Expectation of Life at Birth (LE)

For the years 1971 and 1981 the data on LE have been taken from **Health Information of India** (1971, 1981) and LE for 1991 has been taken from **Report of Standing Committee of Experts on Population Projection**, CSO and SRS based Abridged Life Tables, October 1989.

Crude Death Rate (CDR)

Figures for the years 1971 and 1981 have been taken from the **Health Information of India** (1971, 1981) and the figures for the year 1991 have been taken from **Sample Registration Bulletin** (SRS), July 1993, Vol. XXVII, No. 1, pp. 22–29.

The crude death rate (CDR) is estimated as the number of deaths per one thousand of population.

Infant Mortality Rate (IMR)

Figures of Infant Mortality Rates for the years 1971 and 1981 have been obtained from **Health Information of India** (1971, 1981); while the figures for the year 1991 have been taken from **Sample Registration Bulletin** (SRS) July 1993, Vol. XXVII, No. 1, pp. 46–53.

IMR is measured as the number of infant deaths per one thousand of births.