INTER DISTRICT VARIATIONS AND DETERMINANTS OF HEALTH STATUS INDICES IN THE STATE OF KERALA.

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CERTIFICATE

This is to certify that the Dissertation titled **Inter-district variations and determinants of health status indices in the state of Kerala,** being submitted by S.Suneetha, in partial fulfillment for the award of Master of Public Health, Achutha Menon Centre for Health Science Studies, SCTIMST, Thiruvananthapuram, is a bonafide work carried out by her.

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INTRODUCTION

1.0. INTRODUCTION

Determinants of health are a complex and changing set of factors, which vary in their contribution depending on the history and context of the region. Several studies have emphasized the major impact of social services(water supply, sanitation, education) on the health status of individuals. In the process of recognizing the role of these factors, national health policies have evolved over time from a narrow focus on health infrastructure, to a more broad based approach by including the contribution of social services and economic sector, adopting an integrated approach towards health. It is hypothesized that plausible connections between health and wide range of factors exist - per capita income, health services, biological factors, environmental factors, social services, health sector financing, and health service utilization. Strong correlation's have been demonstrated between most of these factors and health outcome indices (mortality and life expectancy) but the significance of such correlation's has a caveat, i.e. they demonstrate a strong correlation with each other. [1] One needs to investigate whether these factors operate independently on health and to isolate the influence of each by using multivariate analytical methods. The national and state health policy generally tend to be based on macro level data, without accounting for the variation that is evident at the micro level. It is for this reason that the macro level changes once achieved need to focus on micro level changes. A district at micro level is always considered a better unit for delivering health services because it is a compact geo-political region with a better administrative control. Hence, only by knowing the effect of particular

predictor factors at a dis-aggregated level can policy be made at the state and national levels.

I.1. GEOGRAPHIC HETEROGENEITY IN HEALTH STATUS INDICES IN INDIA: There is widespread inter-regional heterogeneity within India across states in terms of health status indices of mortality and life expectancy [2]. Some states of India have mortality levels comparable to that of poorest countries of African continent. This is in spite of the fact that, India has greater financial and manpower resources and a better developmental infrastructure(such as transport, communication, electricity and water supply) in comparison with most of sub-Saharan African countries. These variations within the country among the states post Independence, is possibly due to lack of inter-sectoral cooperation (such as linking of health with education, sanitation, water supply). The following Table 1.1. summarizes the socio-economic indicators in 18 major states of the country reflecting the regional disparities in mortality rates.Regional differences of mortality in India are marked with social advancement of the states, such as the state of Kerala. Kerala is an outlier amongst all states in the country in terms of better health status. Several studies indicate that the people of Kerala enjoy a better standard of health than the other states of India, which is reflected in the health status indices (Infant Mortality Rate and life expectancy)of the state.[3,4,5, 6.] The potential causes attributable to better health status in Kerala are land reforms, female autonomy, female education, public distribution system and health manpower.

Table 1.1: Selected health and social indices in the major Indian states:

state	socio economic				demographic			
	Popln	Poverty	Literacy	Birth	TFR	Death	IMR	LE
Andhra	66.3	27.20	45.1	25.9	3.7	9.5	81	58
Assam	22.3	36.84	53.4	29.4	4.1	10.4	91	52
Bihar	86.3	53.57	38.5	34.3	5.4	12.1	91	53
Gujarat	41.2	32.33	60.9	28.7	3.9	9.7	86	58
Haryana	16.3	16.63	55.3	35.2	4.6	8.5	82	60
H.P	5.1	15.46	60.5	27.7	3.6	8.7	75	60
Kashmir	7.7	23.20	NA	30.1	4.5	7.6	66	60
Karnataka	44.8	38.14	56.0	28.0	3.6	8.8	80	60
Kerala	29.9	32.08	90.6	20.3	2.4	6.1	21	68
Madhya Pradesh	66.1	43.40	43.5	35.5	4.6	12.9	117	52
Maharashtra	78.7	40.10	63.1	28.5	3.5	8.0	59	61
Orissa	31.5	55.61	48.6	30.5	3.8	12.7	121	53
Punjab	20.2	12.70	57.1	28.3	3.5	8.2	64	63
Rajasthan	43.9	34.60	38.8	34.1	5.5	10.7	96	54
Tamil Nadu	55.6	45.13	63.7	23.1	2.8	8.7	68	57
U.P	138.8	41.99	41.7	37.0	5.6	12.6	118	50
West Bengal	68.0	43.99	57.7	27.2	3.7	8.8	77	57
India	**843.9**	**39.34**	**52.1**	**30.6**	**4.3**	**10.3**	**91**	**55**

Popln:Total population (millions in 1991),proportion below poverty line(percent 1987 -88),Literacy(ages>7 years in 1991)Birth and death rates(per 1000 in 1989)TFR- total fertility rate(births per women in 1987-88)IMR - Infant mortality rate(per 1000 live births in 1991) and LE - life expectancy(years in 1990) in India.
source: Das Gupta, Chen,Krishnan. 1996.pg.13.

1.2. REGIONAL HETEROGENEITY IN HEALTH STATUS INDICES IN KERALA - A HISTORICAL PERSPECTIVE :

The state of Kerala located on the southwest coast of Indian peninsula, formally came into existence on Nov 1,1956 on the basis of Linguistic Reorganization Act of 1956. The state was formed after merging of the princely states of Travancore and Cochin, the Malabar region of erstwhile Madras presidency and the Kasargode Taluk of south Canara district of what was the former Mysore state. Based on the historical development and the socio economic conditions, the state is divided into two distinct regions, i.e., six northern districts - Kasargode, Wyanad, Kannur, Kozhikode, Malappuram and Palakkad. The eight southern districts being Thrissur, Ernakulam, Idukki, Kottayam, Alappuzha, Pathanamthitta, Kollam and

Thiruvananthapuram [7]. Ihe history on health status in Kerala, reveals that even before the state's formation in 1956, there were wide disparities in terms of mortality , morbidity, medical manpower and general health status of people in northern districts of Kerala compared to the southern districts. The significant social and economic differences between the erstwhile Malabar region (the present Northern districts) and the Travancore - Cochin region (the present Southern districts of Kerala) have been well documented[8]. The administration of the progressive rulers of the former princely states of Travancore and Cochin gave the southern districts an early start towards the roads of development in the field of health and education long before the independence[8]. This is in spite of the fact that western system of medical care was first introduced in northern districts due to British settlements.

Despite the exceptional achievements in the health status indices at state level there are appreciable differences in the health situation and the health resources between the various geographical and administrative divisions of the state of Kerala. The relative contributions of health infrastructure, social services and economic factors in explaining the intra-state variation in health status indices have not been hitherto investigated systematically in Kerala. This study proposes to evaluate the effects of these factors using data from various districts obtained for the years 1981 and 1991 to understand the level of variation within the districts of Kerala . This is considered essential as the state is presently undergoing transition in its administrative reforms through the decentralization process.

LITERATURE REVIEW
CONCEPTUAL FRAMEWORK
OBJECTIVES

2.1. LITERATURE REVIEW

Studies on relations between inputs to the health process and levels of socio-economic development do not fall into any one discipline; therefore, previous studies have come from many sources, such as historians, epidemiologists, demographers, sociologists and economists. A relatively straightforward study design, involving a group of 18 countries was conducted by examining data on levels of health "inputs" and "outputs" and exploring their relationship by simple cross-sectional correlation analysis was studied for the year 1970. [9] In this study, mortality was used as an output indicator and there were a wide range of input measures covering health services, diet, education, income and population density. The striking relationship found in the study is a positive correlation between infant mortality rate and doctors per 10000 population ("Cochrane's Paradox"). This study gave depth to the idea of connection between development and health, by examining the specific inputs. There has been statistical evidence that some types of interventions are associated with health improvements at national level even when other medical, social and economic factors are held constant. Analysis of IMR in 163 countries reveals 71% of observed variance was due to variation in GNP, bed/1000 population, physicians/1000 population and other health workers/1000 population.[1]

A study was conducted in Mexico [10], using the correlational study design which demonstrated that a strong relationship exists between community's level of development, proximity to medical services and use of maternal and infant health

care. The results of the study show negligible effects of doctors and medical clinics. An ecological association of IMR with per capita income and prevalence of adult illiteracy [11] was also found in a study which analyzed data on 103 countries and showed that adult illiteracy was a good predictor of infant mortality.

A qualitative study examining a number of factors which are believed to be important determinants of infant and child mortality have been analyzed in Nicaragua to study the trends across time.[12] The factors examined included: income, maternal education, nutrition, breastfeeding, immunization coverage, provision of health services, access to water supplies and sanitation, malaria control, and certain cultural aspects of the population. Of all these improved access to health services and efforts in the field of public health made since insurrection appear to have maintained the decline in child mortality in Nicaragua.. Another, qualitative study in Nigeria [13] on the changing African family project, stresses the importance of female education as an intervention mechanism to bring about decline in mortality and fertility.The study says that " education has two roles it increases skills and knowledge as well as the ability to deal with new ideas and provides a vehicle for the import of a different culture". The author links mortality and fertility decline to fundamental social changes. The association between mothers education and IMR and CMR is one of the most thoroughly investigated relationships of recent times and each time its significance has been proved beyond doubt. [14] Economists believe that education raises potential income, productivity and technical information on health care leading to less chances of child mortality. [15]

Rates of infant mortality were found to be heavily influenced by economic, social and environmental conditions and therefore responding better to preventive interventions in those fields than to curative medicine. [16] The results of this study reveal that a large disproportionate share of deaths below age 5 are mainly caused due to gastrointestinal and respiratory diseases. Main factors attributed to these diseases are inadequate health care and low levels of socio economic development , measured in terms of access and utilization of health services. An analysis which throws light on the role of an analytical framework to study child health, emphasizes the need to incorporate both social and medical science methodologies.[17] The key to the model is identification of a set of proximate determinants or intermediate variables that directly influence the risk of mortality and morbidity. All social and economic determinants need to operate through these variables to affect child survival. The proximate determinants envisaged in the framework are: maternal factors, environmental contamination, nutrient deficiency, injury and personal illness control factors.

Increasing rates of mortality were observed among children of low income African - American families in the USA. [18] This is mainly attributed to the intensifying problem of improper health care . The emphasis of this study was on inequity in health care access and other child survival determinants. Poor child health in developing countries continues to be a source of concern and poverty is major factor attributed to affect survival in the early years of life . It is in this context that strong links between poverty and child health were studied.[19] The

several links between social disadvantage and child health, are explained here through factors as growth, physical morbidity, accidents, public health, psychological and developmental disorders. Special emphasis on social variations within countries and role of selective social mobility is also highlighted as contributory cause in the study.

A study on Kerala, Sri Lanka and Costa Rica on how low mortality could be achieved in these regions and whether the same routes could be applied to other poor countries [20] was investigated . The analysis focuses on mortality experience that is markedly at variance with economic determinism as measured by per capita income levels. The three standardized mortality measures used were infant mortality rate, child mortality rate and expectation of life at birth. The social, economic, historical, political and health factors affecting mortality levels of the three regions of the world were studied. It was observed that historically and socially there were striking parallels between the three regions. These parallels included a substantial degree of female autonomy, a dedication to education, an open political system, a largely civilian society without a rigid class structure, a history of egalitarian and radicalism and of national consensus arising from the political contest. The author's main thrust was focused on the contemporary debate of relative importance of medical and health programme and socio economic development variables. Both were considered equally important because the first factor is not effective if the second factor is not achieved. Much of the international advice on maximizing the

rate of economic development may minimize mortality decline and other desirable social services.

Studies in China, Sri Lanka, Costa Rica and Kerala (India) [21] reveal 7 conditions essentially responsible for the fall in mortality and increase in life expectancy in relatively short span of time in these countries. These conditions are: female autonomy, education(female), provision of accessible health services, mechanism to guarantee the efficient operation of health services, adequate minimal standard of nutrition, universal immunization and a commitment to establish effective antenatal and obstetric care.

Studies on Kerala : Several attempts to study the regional disparities within Kerala have been made.[22,23,24,25.] Most studies in the state of Kerala have been contributed by demographers and economists. A study that has analyzed the experiences of two Indian states i.e. Kerala and West Bengal and attempted to explain the reasons for better health status of Kerala when compared to West Bengal in spite of lower level of economic growth[24.] This study produces evidence to support of hypothesis that an important factor that contributed to easier accessibility to and better utilization of health facilities in rural Kerala compared to rural West Bengal was a higher degree of political awareness in rural Kerala at least up to the end of 1970's. The author made an attempt to explain better utilization of health facilities in Kerala in terms of following favorable circumstances: First, smaller catchment areas of rural health centres and better transportation facilities made accessibility easier in Kerala. and second, higher levels of literacy and

education in rural Kerala makes people more conscious of their need for better hygiene, sanitation and medical care and more knowledgeable about effective health practices. Empirical studies on developing countries including Kerala as one of regions under study show that the improvements in the allopathic medical care, better food supply and better household living standards, better transport and communication facilities, water supply and sanitation, expansion of educational facilities as the prime factors responsible for the decline of mortality. One of the studies attributes most of the mortality decline in Kerala to public distribution system, roads and access to health care infrastructure. [26]

2.2. THEORETICAL FRAMEWORK FOR THE STUDY

A framework for the analysis of health status indices (infant mortality and child mortality) should include the interventions/ factors that influence and determine the mortality rate. The theoretical framework for this study is based on Cumper's work in 1984 on 163 countries, wherein he developed a framework based on subsystems involved in determination of national health levels. The framework (fig.2.1) envisaged by Cumper et.al. suggests that within the national health system a significant role can be identified for the following subsystems of relationships. The first column in the figure 2.1 represents certain human subsystems for which, their past and present status are to be linked through the existence of present stocks. The second column in the figure includes the sub-systems connected with development and controlled through human decisions/activities. The last column represents those interventions that are external to human activities but are hypothesized to influence

human activities. For the purpose of our study we modified the framework to suit the district as unit of analysis. The predictor factors which are hypothesized to influence the health status indices(IMR and CMR) in our modified framework (Fig.2.2) are grouped under 4 broad categories:Health services, social services, economic indicators and utilization of services variable.

2.3. OBJECTIVES

In view of the conceptual framework (Fig.2.1), the present study outlines the following objectives :

(i) To examine the specific levels of inter district variation in health, socio - economic and utilization of health services variables within the 12 districts in the state of Kerala.

(ii) To describe variations between districts in health status indices(Infant mortality and Child mortality rates).

(iii) To investigate the determinants of health status indexes(IMR and CMR) for the time period (1981 , 1991 and change over time).

2.4. HYPOTHESES

Based on the review of literature the following hypotheses are generated for testing in the following study:

(i) Increasing number of doctors and para- medical workers would increase access to health care bringing about a decrease in infant and child mortality.

(ii) An increase in the beds and medical institutions would lead to an decline in the IMR and CMR.

(iii) The level of IMR and CMR would tend to decline steeply with the advancement of literacy as mothers education reveals a positive impact on declining IMR and CMR.

(iv) Protected water supply and sanitation improvements can reduce IMR and CMR due to causes like diarrhea.

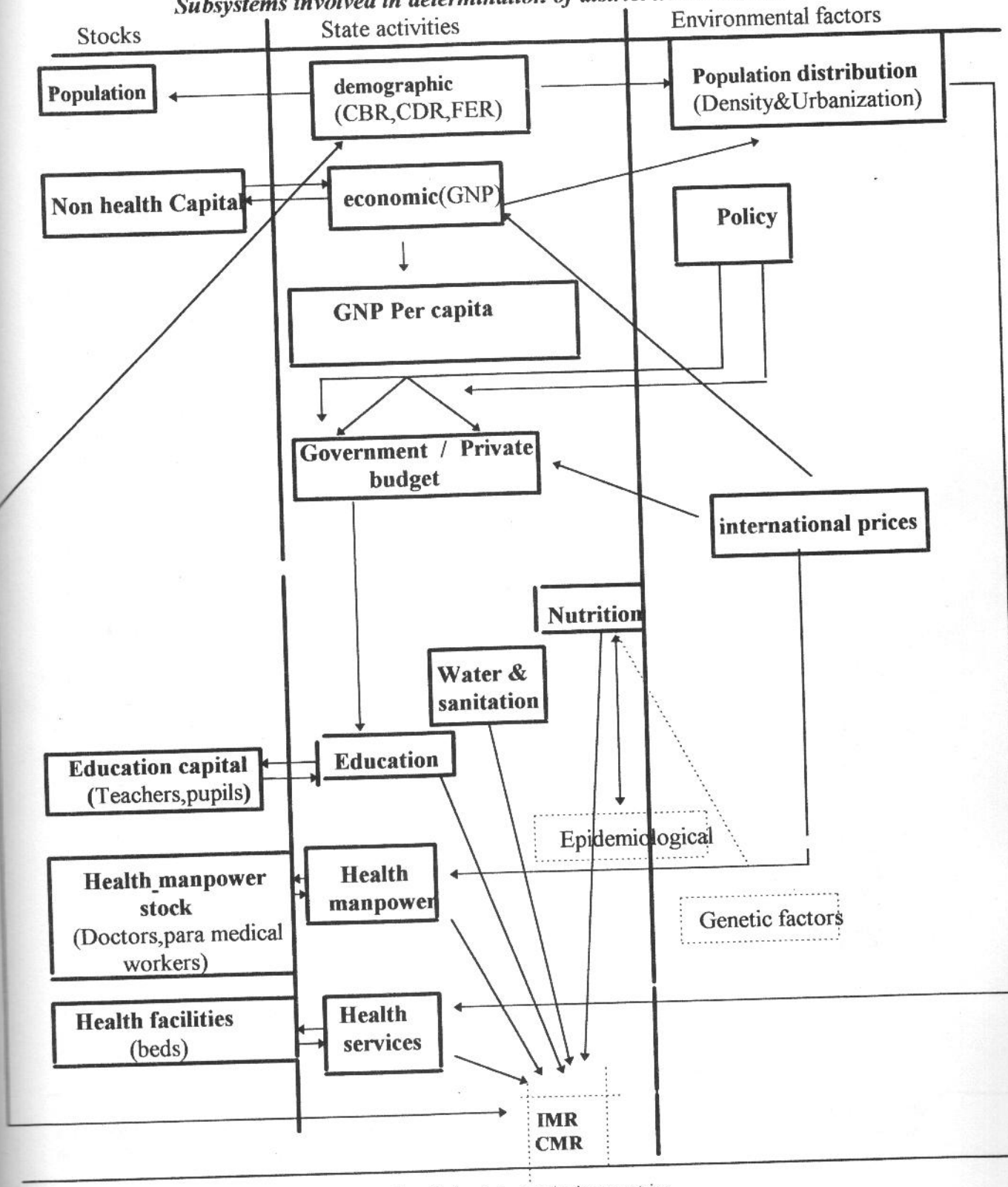
(v) Increasing per capita income of the districts will have a negative impact on the IMR and CMR.

(vi) Urbanization would help to decline Infant and child mortality as it increases access to health infrastructure.

(vii) Improvements associated with governmental policies and influence of other social services would increase the utilization of health care facilities thus decreasing IMR and CMR.

Figure 2.1

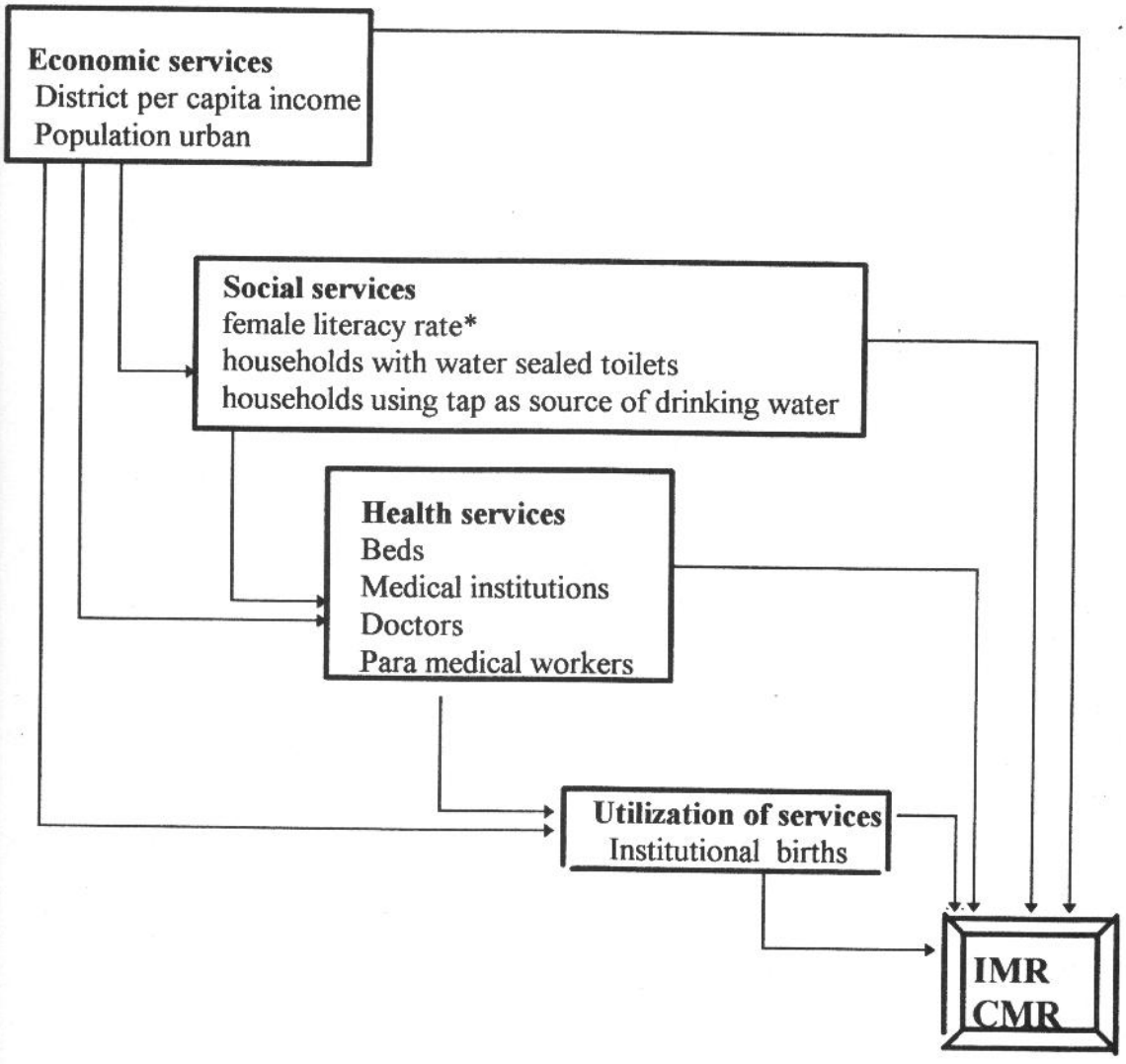
Subsystems involved in determination of district health levels.



Source: G.E.Cumper 1984. Determinants of health levels in developing countries

Figure.2.2

Modified framework used for the present study



Variables not included in the modified framework from the orignal framework are nutrition and its relationship with genetic factors and epidemiological factors. Also expenditure by government and private sector in health sphere was not included due to non- availability of data for the points of interest for the study.

METHODS

3.1. VARIABLES IN THE STUDY

The measures and the symbols used in the study are given in Table 3.1. The measures used are divided into two categories. (a)To measure the health status indices (outcome variables). (b) To measure the predictors (determinants) of the health status indices the following variables are categorized into 4 : health services, social services, economic and utilization of health services variables.

Table.3.1: **MEASURES (VARIABLES) AND SYMBOLS USED IN THE STUDY**

Serial Number	Health status indices variables	symbol
1	**Infant mortality rate**	**IMR**
2	**Child mortality rate**	**CMR**
Health services :	Predictor variables	
1	**Ratio of beds /lakh population**	**RBPN**
2	**Ratio of medical institutions/lakh population**	**RMIPN**
3	**Ratio of doctors/ lakh population**	**RDRPN**
4	**Ratio of para- medical workers/lakh population**	**RPMWPN**
Social services:		
5	**Percentage female literacy**	**FELIT**
6	**Percentage households with water sealed toilets**	**HHWST**
7	**Percentage households using tap as a source of drinking water**	**HHTWD**
Economic services:		
8	**Per capita income (Rs)** (at constant prices)	**PCI**
9	**Percentage of population urban**	**URBPN**
Utilization of services		
10	**Percentage of institutional births**	**INSTB**

See Annexure 1 for detailed description how variables were chosen

Literature shows that IMR as an outome variable is one of the most popular indicators used in most studies all over the world to measure health status of a country.[28,29,10]

3.2. STUDY PERIOD

We choose the time period from 1981 and 1991 to investigate the association of IMR and CMR with potential determinants for the following reasons. Secondary data disaggregated by districts were available on IMR and CMR, for the state of Kerala for these years. Changes due to governmental policies implemented in the 1980's may have resulted in improvements in health outcomes in 1991. Examples of such policy shifts in health care policies include the separation of health sector funds for sanitation and water supply and the de-linking of Employees State Insurance health scheme(ESI) funds from the state health plan funds in the early 1980's. The implementation of the India population project in 1984 especially in the northern and hilly regions of Kerala state resulted in an improvement in health care infrastructure and an increase in health care utilization over this time period.

3.3. SOURCES OF DATA

The study is based on analysis of secondary data. Available data was fully utilized to analyze the trends and inter district differentials in health status indices in Kerala.

1. Sources used in the study: Different sources of data have been used for different variables under study. Table of sources used and the original definition of each variable in the study is attached. (ANNEXURE II). Where ever possible definition of original sources of data have been used, except for one of the social

service variable i.e. percentage households using tap as a source of drinking water where definition needed to be modified. The infant mortality and child mortality estimates were derived by the sources used, based on Brass and Trussels techniques (calculated by taking the ratio of surviving children and children ever born of mothers classified by five year age group). The rationale behind using this method is the proportions of children dead, of ever born children classified by age of the mother for all women of a certain ages correspond to discreet child survival probabilities. These survival probabilities are then used to calculate IMR assuming a typical age pattern of mortality. And then using the fertility schedules developed the expectation of life at birth for age 2, age 3 and age 5 were worked out from the South Asian pattern of model life tables and their average was taken.

2. Assumptions made: All data are from the official census / surveys except in a few cases where estimates had to be made. These estimates are given below. Since, 70 percent of Kerala population seeks medical care from the private sector [27] we wanted to combine both private and public sector health services for the predictor variables used in our investigation. While the statistics on Public sector for health services variables are available, we could not find data on health services in Private sector for the years 1981 and 1991. We therefore decided to intra-polate from the available sources of data for the health services variables(1985 and 1995 sources). Data for health services variables in the private sector for 1981 and 1991 were calculated by assuming that the growth rate would have remained the same between 1981 and 1991, as between 1985 and 1995. We applied the growth rate

formula and calculated backwards for the years of interest. Census statistics were used to study the changes on female literacy, domestic water supply (using tap as a source) and households having provision of toilet facility. Since census in 1981 covered only urban areas to assess the percentage households with water sealed toilets and did not include rural areas, we could not make use of Census data for 1981 to derive total percentage households having water sealed toilets. Hence, we used a survey data collected for the entire state in 1980 by the government of Kerala as a source, assuming that the situation might have remained the same for 1981.

3.Quality of data used: It is generally acknowledged that the Sample Registration Survey (SRS) is an authentic source for data on health status indicators(IMR and CMR)in Indian states. Data on IMR and CMR on district level aggregates are not provided by SRS. We, therefore used district level estimates of health status indices calculated by Census in 1981 and Rajan et.al, for 1991 .

3.4. STATISTICAL METHODS USED

The number of districts changed between 1981 and 1991 due to the bifurication of Kollam and Kannur districts in this period, into Kollam and Pathanamthita and Kannur and Kasargode respectively. As a result there were, 14 districts in 1991 compared to 12 districts in 1981. We therefore combined 1991 data (weighted average) available for Kasargode with Kannur district and Pathnamthitta district with Kollam district, (based on the largest area gone in the formation of the new district) so that we could compare corresponding regional units in 1981 and 1991.

Thus, the number of observations for each variable was 12 corresponding to the 12 districts existing in 1981. We used the epidemiological approach of correlational study design to describe variations within districts and associations between mortality and predictor variables. In order to analyze the inter district variations in each of the outcome and determining variables we used the statistical methods of **standard deviation and coefficient of variation**. In order to investigate the effect of the predictor factors on the outcome variables (IMR and CMR), the statistical methods of **correlation and step wise forward regression analysis** were used. Correlation analysis was used mainly to assess the association between the hypothesized variables and the outcome variables(IMR and CMR). Step-wise regression analysis is used to determine the relative impact of various predictor variables on the outcome of interest. The analysis consisted of 2 stages:

a. We assessed the contributions of various predicting factors on the health status indices (LEVELS) by performing step wise regressions for the years 1981 and 1991seperately.
b. We identified the percentage change of outcome variables(IMR and CMR) over the decade (1981 -1991) and evaluated its associations with the percentage changes in the determining variables over the same period of time using step wise forward regression analysis.

RESULTS

INTER DISTRICT VARIATIONS AND TRENDS

4.1. INTER-DISTRICT VARIATIONS IN HEALTH STATUS INDICES

Inter district variation in infant mortality:. In Kerala, in 1981 , infant mortality rate was highest in Wyanad district and Idukki district (108 and 103 respectively) (Table 4.1). However in 1991, the IMR for these districts has declined substantially compared to all other districts. Although the IMR in 1981, for Thiruvananthapuram district was 52 it has declined to 25 (the lowest for any district in Kerala) in 1991, but in terms of percentage decline it ranks third among all the districts at 51.92%.

Table 4.1: **Infant Mortality Rate per 1000 live births in various districts in Kerala state in 1981 - 1991.**

DISTRICT	IMR 1981	IMR 1991	% change
Northern districts			
KNR	45	35	-22.22
WYN	108	36	-66.67
KZK	54	43	-20.37
MLPM	49	36	-26.53
PLGT	64	36	-43.75
Southern districts			
TRCH	52	38	-26.92
ERNK	40	36	-10.00
IDK	103	43	-58.25
KTM	59	35	-40.68
ALP	38	35	-7.89
KLM	46	36	-21.74
TVM	52	25	-51.92
Kerala	54	37	-31.48

KNR-Kannur,WYN-Wyanad,KZK-Kozhikode,MLPM-Malappuram,PLGT-Palakkad TRCH-Thrissur,ERNK-Ernakulam,IDK-Idukki,KTM-Kottayyam,ALP-Alleppey,KLM-Kollam, TVM- Thiruvananthapuram.

Sources: Child mortality estimates of Kerala, India. Registrar General 1988. Occasional paper of 1988. Controller of publications.New Delhi. Working paper: Long term implications of low fertility in Kerala Oct. 1997. Irudaya Rajan and K.C. Zachariah. CDS. Trivandrum.

The percentage decrease was maximum between 1981 and 1991 in Wyanad and Idukki district at the rate of 66.67% and 58.25% respectively and least decrease in Allepey district (7.89%). Thus the inter-district variation in IMR has considerably narrowed down by 1991 among the districts in Kerala.

Inter district variation in child mortality: Trends in child mortality rate show that it was higher in northern districts in 1981 than in southern districts(Table 4.2).

Table 4.2: **Child Mortality Rate across districts of Kerala for 1981 and 1991.**

DISTRICT	CMR 1981	CMR 1991	% change
Northern districts			
KNR	85	44	-48.24
WYN	109	58	-46.79
KZK	80	50	-37.50
MLPM	105	57	-45.71
PLGT	113	56	-50.44
Southern districts			
TRCH	70	46	-34.29
ERNK	62	42	-32.26
IDK	86	56	-34.88
KTM	55	39	-29.09
ALP	68	42	-38.24
KLM	71	42	-40.85
TVM	68	31	-54.41
Kerala	80	46	-42.5

Sources: Child mortality estimates of Kerala. India. Registrar General 1988 Occasional Paper No 5 of 1988. Controller of Publications. New Delhi. Working paper. Long term implications of low fertility in Kerala .Oct 1997. Irudaya Rajan and C.Zachariah, CDS,TVM.

In 1981, CMR was highest in(33 points higher than state average) Palakkad district(113) and lowest in Kottayam district(55). In 1991, almost all the districts show a decline in CMR in comparison to 1981. Still, districts of Wyanad, Malappuram, Palakkad and Idukki and Kozhikode registered for higher change than the average of the whole state. The lowest child mortality was observed for

Thiruvananthapuram district (31) in 1991 . In terms of percentage decline in CMR between 1981 and 1991 maximum decline is noticed for Thiruvananthapuram district (54.41%) and least decline was observed for Kottayam district (29.09%). The percentage decline was much higher in northern districts for the decade.

4.2. INTER DISTRICT VARIATIONS IN PREDICTOR VARIABLES All the predictor (determinant) variables have been classified into 4 categories as health services variables, social services variables, economic variables and change variables. To begin with ,we will, discuss about the general growth in the health services in Kerala.

Table 4.3: **GROWTH IN HEALTH SERVICES IN KERALA 1981 -1991.**

Variable	1981	1991	% change	% change per lakh population
Infrastructure				
Medical Institutions	4251 **(16.70)**	5225 **(17.96)**	22.91	**(7.54)**
Beds	72842 **(286.17)**	101107 **(347.12)**	38.80	**(21.03)**
Personnel				
Doctors	8293 **(32.58)**	12776 **(43.90)**	54.05	**(34.77)**
Para- medical workers	20928 **(82.22)**	33782 **(116.09)**	61.43	**(41.19)**

figures in ( ) refer to ratios of the particular variable / lakh population.

Table 4.3 presents the increase in medical infrastructure and manpower in Kerala during 1981 and 1991. Maximum increase is noticed in the para- medical work force (61.43%), followed by growth in doctors across the state (54.05%) during

this time period. Within the infrastructural variables greater increase is observed in number of beds (38.80%). The increase in medical institutions made the least growth in the state during the last decade (22.91%) this is possibly due to the fact that,medical institutions as a variable is limited as its size varies. The population served by each of these indicators provides better insight about the potential utility of the health services. The last column of Table 4.3, therefore tabulates the values of these indicators per lakh population. This indicates that the ratio of health personnel has increased in Kerala during the reference period.

4.2(A). *INTER DISTRICT VARIATION IN SELECTED HEALTH SERVICE VARIABLES*

Inter district variation in availability of hospital beds: The highest availability of beds in absolute figures are indicated for 1981, in Ernakulam district (1164) and the same position is retained by the district even for 1991(1722). Wyanad district represents the least number of beds for both points of time(221 and 241 respectively). The availability of beds has increased in all districts due to increase in private sector beds. The ratio of beds available by district in Kerala, in 1981 and 1991 is presented in Table 4.4. The last column in the Table 4.4 shows the percentage increase in availability of beds in the districts. We notice that , maximum increase in bed population ratio between 1981 and 1991, is made by Palakkad district (69.58%), followed by Malappuram (46.08%) mainly attributable to the implementation of India Population Project in the northern and hilly districts . The least increase is observed in Allepey district (4.82%). These data suggests that

availability of hospital beds is more in districts where medical colleges are located viz. Kottayam, Thiruvananthapuram, Kozhikode, Alleppey and Thrissur districts

Table 4.4: **Availability of hospital beds per lakh population by district in Kerala in 1981 -1991**

DISTRICT	beds / lakh population 1981	1991	% change
Northern districts			
KNR	187.30	230.54	23.08
WYN	344.58	364.29	5.71
KZK	246.82	285.38	15.68
MLPM	103.58	151.29	46.08
PLGT	96.82	164.19	69.58
Southern districts			
TRCH	306.15	427.04	39.48
ERNK	435.46	516.86	18.67
IDK	386.69	424.86	9.87
KTM	494.64	603.28	21.96
ALP	374.54	392.60	4.82
KLM	272.30	390.35	43.35
TVM	348.46	375.81	7.84
Kerala	**286.17**	**347.12**	**21.30**

Sources: (Govt) Govt. of Kerala. Statistics for planning 1983. Dept of economics. and statistics Trivandrum.(Pvt) Govt of Kerala report on survey of private medical institutions in Kerala 1985. Dept of economics and statistics.TVM 1986. (Govt) Administrative report - Directorate of Health Services 1991. TVM.(PVT) Govt. of Kerala - report on survey of private medical institutions in Kerala, 1995. Dept of economics and statistics TVM 1996 (in press).

.Inter-district variation in medical institutions: In absolute figures highest number of medical institutions are located in Kollam district (624), in 1981 and the same position is retained by the district (746) in 1991. However, the lowest number of medical institutions are observed in Wyanad district (108 in 1981 and 143 in 1991). All the districts show an increasing trend except for Allepey district. We find that the growth of medical institutions in private sector is at a faster rate than the government sector. Thus we observe vast inter district variation in health

infrastructure as medical institutions, mainly private, tend to concentrate in and around urban areas. In terms of ratio of medical institutions per lakh population, Alleppey district ranks the highest (26.37) and Palakkad district ranks the lowest (9.93) in 1981. In 1991, Kottayam district has the maximum ratio (28.28) and Malappuram the lowest ratio(10.72). (Table 4.5).

Table 4.5: **Number of medical institutions in districts of Kerala state 1981 -91.**

DISTRICT	Medical institutions per lakh population		% change
	1981	1991	
Northern districts			
KNR	14.97	16.19	8.14
WYN	19.49	21.28	9.18
KZK	11.22	15.53	38.41
MLPM	10.57	10.72	1.42
PLGT	9.93	11.34	12.43
Southern districts			
TRCH	13.81	14.18	2.68
ERNK	19.37	21.90	13.06
IDK	22.91	26.25	14.58
KTM	23.69	28.28	19.38
ALP	26.37	23.24	-11.87
KLM	18.90	20.75	10.53
TVM	16.99	17.61	3.65
Kerala	**16.70**	**17.96**	**7.54**

Sources: (Govt) Govt. of Kerala. Statistics for planning 1983. Dept. of economics and statistics. (Pvt) Govt. of Kerala - report on survey of private medical institutions in Kerala 1985. Dept. of economics and statistics.Trivandrum 1986. (Govt) Govt. of Kerala. Directorate of Health Services. 1991. Trivandrum. (PVT) Govt. of Kerala - report on survey of private medical institutions in Kerala. 1995. Dept. of economics and statistics. TVM. 1996 (in press).

However, in terms of percentage increase, the maximum increase during the decade is evident in Kozhikode district (38.41%) and least increase is noticed in

Malappuram district (1.42%). All the districts of Kerala, show a increasing trend between 1981 and 1991 but for Alleppey district where a decline of 11.87% was observed. This decline in medical institutions per lakh population in Alleppey district may be due to part of the district having gone to the formation of new disrict of Pathanamthita in 1983.Therefore, the medical institutions which were counted as part of Alleppey district in the survey published in 1985 were subsequently counted in Pathanamthita district in the 1995 survey.

Inter-district variation in doctor population : In absolute figures the availability of doctors is highest in Ernakulam district(1164) and the lowest in Wyanad district (221) in 1981. In 1991, the same districts account for the highest and lowest number of doctors (1722 and 241 respectively). It is interesting to note here that in Wyanad district, there has been a reduction in Government doctors by 71 points between 1981 and 1991 and an increase in the private sector doctors by 91 points. The same trend is seen in Idukki district . In terms of doctors per lakh population in 1981, the highest ratio is observed in Kottayam district (48.73) and lowest ratio is observed in Palakkad district (16.63). In 1991, Kottayam retains the highest ratio (73.14) and the lowest ratio is observed in Malappuram district (21.96).(Table 4.6).In terms of increase in doctor population ratio over the decade(1981 - 1991) we find that the district of Palakkad made the maximum increase (50.93%). The least increase during the decade was made by Idukki district (1.50%) However, it is interesting to note that when all the districts were showing an increasing trend, the district of Wyanad was showing a declining trend (-10.10%) in doctor population

ratio over the last decade. This is due to the fact that the district made only marginal increase in absolute number of doctors and there was marked increase in the population during the same period. Also there has been a tremendous decline in the number of government doctors posted in district. This has been attributed to lack of proper living conditions for the doctors (Kerala Government Medical Officers Association Jan 14. 1998). In general, the districts where teaching hospitals are located, maintain a higher number of doctors, leading to wide inter district variation in doctor population ratio.

Table 4.6: **Doctors per lakh population in districts of Kerala state 1981 - 1991.**

Districts	Doctors per lakh population 1981	1991	% change
Northern districts			
KNR	24.96	30.48	22.12
WYN	39.89	35.86	-10.10
KZK	31.67	46.22	45.94
MLPM	20.10	21.96	9.25
PLGT	16.63	25.10	50.93
Southern districts			
TRCH	31.00	46.29	49.32
ERNK	45.92	61.13	33.12
IDK	39.94	40.54	1.50
KTM	48.73	73.14	50.09
ALP	46.68	48.88	4.73
KLM	34.20	44.27	29.44
TVM	41.68	57.69	38.41
Kerala	**32.58**	**43.91**	**34.78**

Sources: (Govt) Govt of Kerala - study on migration of medical and para- medical personnel from health services. Manpower study series No 46. Manpower division. Dept. of economics and statistics. Trivandrum .May 1984.(Pvt) Govt. of Kerala. Report on survey of private medical institutions in Kerala 1986. Dept. of economics and statistics Trivandrum. (Govt) Manpower register 1991. Directorate of Health Services (unpublished). (Pvt) Govt of Kerala. Report on survey of Private Medical institutions in Kerala 1995. Dept. of economics and statistics. Trivandrum (inpress).

Inter-district variation in Para-medical workers: This category includes all nurses, pharmacists and lab technicians, in both government and private sectors. In absolute figures in 1981, highest number of total para-medical workers were engaged in Ernakulam district (3069) and the lowest number in Wyanad district (411). In 1991, the same districts account for the highest(4603) and lowest (888) numbers of para medical workers. One needs to notice here, that in 1991, there has been an increase in number of government sector para medical work force in 4 of the northern districts in comparison with most of southern districts of Kerala. The 4 districts being Kannur, Kozhikode, Malappuram, and Palakkad. In 1981, the number of para medical workers per lakh population is noticed to be highest for Kottayam district (132.35) and Malappuram district had the lowest ratio(31.46)(Table 4.7). In 1991, Ernakulam district had the highest ratio (163.40) and Malappuram district had the lowest ratio (76.45). In terms of increase in ratio of para medical workers per lakh population we find, maximum increase between 1981 -1991, has taken place in Malappuram district (143.01%) which is incidentally the highest beneficiary of family welfare programmes in the state during the 1980's. The lowest increase is noticed for Alleppey district (29.34%). The districts of Kannur, Palakkad, Malappuram and Kozhikode district have accounted for the largest increase during this period . Thus we find that the inter district variation in terms of number of para medical workers per lakh population, has narrowed down between northern and southern districts between 1981 and 1991. In terms of medical personnel, we observe that the number of para medical workers have increased

mostly in the northern districts, whereas the doctors per lakh population have increased in districts where medical colleges are located.

Table 4.7:**Number of para medical workers in districts of Kerala state1981-91**

Districts	Para medical workers per lakh population 1981	1991	% change
Northern districts			
KNR	44.86	99.82	122.51
WYN	74.19	132.14	78.11
KZK	43.25	90.95	110.29
MLPM	31.46	76.45	143.01
PLGT	36.35	85.81	64.40
Southern districts			
TRCH	76.80	113.26	47.40
ERNK	121.07	163.40	34.96
IDK	85.24	157.42	84.68
KTM	132.35	161.60	33.63
ALP	86.97	112.49	29.34
KLM	79.46	134.90	69.77
TVM	83.39	112.86	35.34
Kerala	**82.22**	**116.19**	**41.19**

Sources: same as in Table. 4.6.

GROWTH IN SOCIAL SERVICE VARIABLES

Among the 3 social services variables considered in the present investigation, viz. female literacy, households with water sealed toilets and households using tap as a source of drinking water. Sanitation facilities have increased the most in the state(183.60%). A lesser degree of increase is noticed for households using tap as a source of drinking water (48.36%). And the least increase amongst the social services variables is observed for female literacy(29.72%). (Table 4.8).

Table 4.8: **GROWTH IN SOCIAL SERVICES IN KERALA 1981 - 1991 .**

Variable	1981	1991	% increase 1981-91
Female literacy (%)	64.82	85.27	29.72
Hh's with toilet(%)	18.25	51.76	183.60
Hh using tap (%)	11.95	17.73	48.36

4.2(B). ***INTER DISTRICT VARIATION IN SELECTED SOCIAL SERVICES VARIABLES***

Inter district variation in female literacy rate : Improvements in IMR and CMR in Kerala is often attributed to the high level of female literacy. [3, 6, 30.] We present here the narration in female literacy rates in different districts and the percentage change in this variable from 1981 to 1991.(Table 4.9).

Table 4.9: **Female Literacy rates in districts of Kerala states 1981 -91.**

District	Female literacy rate 1981	1991	% change
Northern districts			
KNR	59.48	84.08	41.36
WYN	51.51	77.69	50.83
KZK	63.82	86.79	35.99
MLPM	55.34	84.09	51.95
PLGT	51.55	75.72	46.89
Southern districts			
TRCH	70.21	86.94	25.41
ERNK	72.88	89.27	22.49
IDK	62.55	82.96	32.63
KTM	79.35	94	18.46
ALP	75.10	91.12	21.33
KLM	70.21	89.11	26.92
TVM	65.85	85.76	30.24
Kerala	**65.73**	**85.27**	**30.28**

Sources: Census of India. Kerala 1981. Paper 3. Series 10. Registrar General of India .Census of India Kerala 1991. Registrar General of India.

In 1981, as well as in 1991 Kottayam district attained the highest female literacy rate(79.35% and 94% respectively). The lowest female literacy rate is observed for Wyanad district in 1981(51.51%). By 1991, female literacy rate had substantially increased in Wyanad district. Data for 1991 reveal that Palakkad district lagged behind other districts in female literacy rate (75.72%). Though this is a low rate relative to other districts, it is comparatively still higher than that of many of the other states in India. In 1981, all the northern districts and Idukki district in the southern region of Kerala were below the state average . However by 1991, but for 2 districts in the northern region all other districts in the northern region were comparable with the southern districts and close to the state average. (Table 4.9). The increase in female literacy rate between the two points of interest, shows that Malappuram district made the highest increase(51.95%) As female literacy rate was quite high by 1981 itself in Kottayam district, we observe that by 1991, this district shows the least increase (18.46%) .The inter district variation in this variable has markedly reduced between 1981 and 1991.

Inter district variation in households with water sealed toilets : Studies in UK in the first 4 decades of the century reveal a significant fall in the infant mortality in spite of the two world wars in which UK was involved, due to sterilization and improvement in environmental sanitation [6]. The number of households having this provision was divided by the total households in the district. In 1981, Ernakulam district had the highest number of households with water sealed toilets(30.53%). Malappuram district(10.82%). had the lowest percentage of households with water

sealed toilets. It is of interest to note here that Wyanad district was not covered by the Census as well as by the survey in 1980. In 1991, Ernakulam district had the highest percentage of households(67.39%) and Wyanad district accounted for the lowest percentage of households (26.79%) with toilets. Five districts in the state in 1991 were below the state average of 51.76% viz. Kannur, Wyanad, Malappuram, Palakkad and Idukki district (Table. 4.10). Most of the northern districts are lagging behind in this facility when compared with southern districts of Kerala at both points of time.

Table 4.10: **Number of Households having water sealed toilets in districts of Kerala state in 1981 -1991**

Districts	% households with water sealed toilets		% change
	1981	1991	
Northern districts	12.80	41.11	221.17
KNR	NA	26.79	NA
WYN	18.83	59.49	215.93
KZK	10.82	47.14	335.67
MLPM	12.89	30.44	136.15
PLGT			
Southern districts	23.52	63.63	170.54
TRCH	30.53	67.39	122.92
ERNK	13.73	31.95	137.55
IDK	21.73	55.33	154.62
KTM	21.55	50.50	134.34
ALP	17.63	51.35	191.26
KLM	19.16	58.92	207.52
TVM			
Kerala	**18.25**	**51.76**	**183.60**

Sources: 1980, Govt. of Kerala - survey on housing and employment. 1980, Directorate of economics and statistics. Trivandrum. Census of India 1991, series 12 Kerala - tables on houses and household amenities Part VII. Table No: H5. Registrar General of India.

However, when we evaluate percentage change in households with toilet facilities over time, we can infer that the Northern districts witnessed the largest increase in during the time period studied. Highest increase in households having water sealed toilets during 1981 - 1991 is noticed for Malappuram district(335.67%) and the least increase is witnessed in Idukki district(122.92%). The inter -district variation regarding this provision of water sealed toilets, has significantly narrowed down between 1981 - 1991. (Table 4.10). The State Planning Board reports that in terms of public investment sanitation sector is one of the least developed sectors in Kerala.[31.]

Inter district variation by households using tap as a source of drinking water :

Modification has been made for this variable to the original Census definition which considers water drawn from tap, tube well and hand pump as safe for drinking purpose. But in the study, only tap water was considered as safe drinking water based on regional water resources. In 1981, the highest percentage of households using tap water as a source of drinking water was observed in Ernakulam district (24.43%). And the lowest percentage of usage of tap water was noticed for Malappuram district (2.39%). In 1991 too, Ernakulam district ranked as the highest user of this provision(45.51%) and the lowest user of tap water was Kannur district (5.77%).(Table 4.11). In terms of percentage change, it is interesting to note that the district with least utility (Malappuram) in 1981, showed the maximum increase (164.85%) in terms of utility of tap water. The least increase between 1981 and 1991, in terms of utility of this provision is noticed for Kozhikode district

(15.11%). Three districts in the state of Kerala, in terms of percentage increase in utility of tap water lag much behind the state average viz., Thiruvananthapuram, Idukki and Kozhikode districts (28.70%,15.78% and 15.11% respectively). Thus the inter district variation has increased regarding the utility of this provision between 1981 and 1991.

Table 4.11: **Percentage households using tap as source of drinking water in districts of Kerala state. 1981 - 1991.**

District	% households using tap as source of drinking water		% change
	1981	1991	
Northern districts			
KNR	4.11	5.77	40.39
WYN	9.07	12.41	36.82
KZK	9.40	10.82	15.11
MLPM	2.39	6.33	164.85
PLGT	10.05	18.82	87.26
Southern districts			
TRCH	7.69	14.19	84.53
ERNK	24.43	45.51	86.29
IDK	17.68	20.47	15.78
KTM	10.25	17.78	73.46
ALP	12.27	23.96	95.27
KLM	6.62	11.36	71.60
TVM	18.36	23.63	28.70
Kerala	**11.95**	**17.73**	**47.20**

Sources: Census of India 1981. Series 10. Kerala. Part VII A and B. Household Tables HH7. Household by source of drinking water .Registrar General of India. Census of India 1991. Series 12. Kerala. Part VII. Tables on houses and household amenities. Table H5 households classified by source of drinking water availability, electricity and Toilet facility.

GROWTH IN ECONOMIC INDICATORS.

The two economic variables considered in the present investigation are Per Capita income and percentage urban population. The percentage population urban shows a

significant increase. A lesser degree of increase was noticed for per capita income (20.56%) for the state of Kerala.(Table 4.12).

Table 4.12: **GROWTH IN ECONOMIC INDICATORS IN KERALA 1981-91.**

Variable	1981	1991	%increase 1981 -91
PC Income(Rs)	1508	1818	20.56
Urbanization(%)	18.74	26.44	41.08

4.2(C) *INTER DISTRICT VARIATION IN SELECTED ECONOMIC INDICATORS*

Inter district variation in per capita income(at constant prices): In 1981, the highest per capita income was accounted by Ernakulam district, as anticipated (Rs. 2017) and the lowest per capita income was accounted by Malappuram district (Rs. 1045).

Table 4.13:**Per capita income(at constant 1980 - 81 prices) of districts in Kerala state in 1981-91.**

Districts	Per capita income (Rupees) 1981	1991	% change
Northern districts			
KNR	1508	2406	7.03
WYN	NA	2100	NA
KZD	1588	1724	8.56
MLPM	1045	1091	4.40
PLKD	1307	1590	21.65
Southern districts			
TRCH	1462	1821	24.56
ERNK	2017	2536	25.73
IDK	1995	2376	19.10
KTM	1452	1916	31.96
ALPZ	1311	1879	43.33
KLM	1536	1846	28.71
TVM	1484	1868	25.88
Kerala	**1508**	**1818**	**20.56**

Source: Table 15.7(6) Govt. of Kerala. statistics for planning. 1993. Dept. of economics and statistics. Trivandrum.

In 1991, too Malappuram district shows the lowest per capita income (Rs. 1091) and the highest was accounted by Ernakulam district (Rs 2536).(Table 4.13). However, in terms of percentage change in per capita income, maximum increase is noticed in Alleppey district (43.33%) and the minimum increase is observed in Malappuram district (4.40%). Ironically this is the district which today accounts for the highest of gulf remittances into the state. Thus, all the districts show only an marginal increase in per capita income at constant prices for 1981 and 1991.

Inter district variation in urban population : As already mentioned in the choice of variables about the limitation in usage of per capita income as a predictor variable, we decided to choose percentage urban population as a proxy for economic variable.

Table 4.14: **Percentage of urban population in districts of Kerala state 1981 -91.**

District	% population urban 1981	1991	% change
Northern districts			
KNR	18.36	39.87	70.53
WYN	NA	3.41	NA
MLPM	27.18	38.42	41.53
KZK	7.40	9.13	23.38
PLGT	10.11	15.75	55.69
Southern districts			
TRCH	21.10	26.32	24.74
ERNK	39.56	48.79	23.33
IDK	4.60	4.73	2.82
KTM	9.37	17.56	87.41
ALP	15.89	30.62	92.70
KLM	13.15	16.76	58.26
TVM	25.26	33.95	34.40
Kerala	**18.74**	**26.44**	**41.08**

Source: Census of India 1991. series 12. Kerala. Paper 2 of 1991 Provisional population totals - rural urban composition workers and their distribution.

An increase in urbanization represents an increasing access to health care.[32] In 1981, the district with least percentage of urban population was Idukki (4.60%) and Ernakulam district had the highest percentage of urban population (39.56%)(Table 4.14). It is of interest to note here that Wyanad district had no urban population in 1981. In 1991, Ernakulam district accounted for highest percentage of urban population(48.79%) and Wyanad district had the lowest percentage of urban population (3.41%). In terms of trend (1981-1991), we find that, maximum increase in urban population is observed in Alleppey district (92.70%) and the minimum increase is noticed in Idukki district (2.83%).(Table 4.14). One needs to mention here that, Idukki and Wyanad are largely tribal districts which have large scale plantations in agricultural sector the produce being exported to urban centres along the coast. However, some of the districts show a higher degree of urbanization due to increase in population living in the outgrowth areas of city limits which are considered in the definition of urban according to the source used. Thus, all districts in the state have shown increasing trend of urbanization between 1981 and 1991. Large inter district variation exist in the context of this variable within districts.

4.2.(D) *INTER-DISTRICT VARIATION IN UTILIZATION OF SERVICES*

Inter district variation in institutional births : Higher percentage of institutional births by 1981, was a well established fact for the state of Kerala in comparison with rest of the states in India[6]. Variations within districts in the context of this variable is quite noticeable in 1981. The data on percentage of institutional births to total

live births in the district show that in 1981, Kottayam district had the largest percentage (92.07%) and Malappuram district (40.74%) had the smallest percentage of institutional births. In 1991, too of Malappuram district had the lowest percentage (76.94%) and Thiruvananthapuram district (99.97%)had the highest percentage of institutional births.

Table 4.15: **Percentage of institutional births per total live births by district in Kerala 1981 - 1991.**

District	% institutional births 1981	1991	% change
Northern districts			
KNR	70.85	97.92	38.21
WYN	60.00	81.69	36.15
KZK	78.69	97.51	23.92
MLPM	40.74	76.94	88.86
PLKD	47.76	89.71	87.84
Southern districts			
THRS	84.01	99.34	18.25
ERNK	95.10	99.97	5.12
IDK	65.51	96.32	47.03
KTM	92.07	99.60	8.18
ALP	82.82	96.24	16.20
KLM	86.14	98.80	14.70
TVM	87.20	99.79	14.44
Kerala	**74.05**	**94.46**	**27.56**

Sources: Govt. of Kerala. Vital statistics 1981. Dept. of economics and statistics TVM. Govt. of Kerala. Vital statistics 1991. Dept. of economics and statistics. TVM.

All the 7 southern districts of Kerala reflect more than 95% of institutional births in 1991. Only two of the northern districts viz. Kannur and Kozhikode show more than 95% institutional births. The other 3 districts trailing much behind in 1991. However, in terms of percentage increase in institutional births(1981 - 1991) the lowest increase is noticed in Ernakulam district(5.12%), and the highest increase in

Malappuram district (88.86%)(Table 4.15) Ernakulam district showing a low trend, is due to the fact that the district by 1981 itself attained a high percentage of institutional births. We find that significant change was made by the northern districts in terms of institutional births between 1981 and 1991. Thus there is a narrowing in the inter-district variation in the context of this study variable.

4.3. EXTENT OF INTER DISTRICT VARIATION IN IMR AND CMR

(HEALTH STATUS INDICES)

In 1981 the range of variation in IMR is indicated by the highest estimate of 108 for Wyanad district and lowest estimate of 38 for Alleppey district. (Table 4.16). Corresponding highest and lowest estimate of IMR for 1991 are 43 for Kozhikode and Idukki districts respectively. and 25 for Thiruvananthapuram district. In terms of child mortality the range of variation for 1981 is indicated by the highest, the lowest and the state average at 80 for 1981. In 1991 the highest and lowest estimate of CMR have considerably narrowed down resulting in decrease of the state average (46). The standard deviation and coefficient of variation represents the extent of increase or decrease in inter district variation between 1981 and 1991 .The coefficients of variation as shown in Table 4.16 suggests, a faster decline in inter-district variation for IMR than CMR between 1981 and 1991.

Table 4.16: **Measures of outcome variables showing extent of inter district variation for 1981 - 1991**

Variable	Year	average	Min	Max	range	std. dev	coef var.
IMR	1981	54	38	108	70	22.86	0.38
	1991	37	25	43	18	4.53	0.12
CMR	1981	80	55	113	58	19.12	0.23
	1991	46	31	58	27	8.49	0.18

4.4. EXTENT OF INTER-DISTRICT VARIATION IN PREDICTOR VARIABLES

Table 4.17 presents the average, standard deviation and coefficient of variation of the above mentioned predictor variables for the years 1981 and 1991. The standard deviation and coefficient of variation indicate the inter-district variation and changes thereoff, during 1981 and 1991. The averages of all the variables in the study show an increasing trend in terms of health services variables, socio economic variables and utility variable. Among the health services indicators, the ratio of doctor population(RDRPLN) shows an increasing trend of inter-district variation wherein, the coefficient of variation has increased from 0.30 in 1981 to 0.34 in 1991. While ratio of beds per lakh population and ratio of para medical workers per lakh population show a declining trend of inter district variation. The ratio of medical institutions per lakh population has almost remained the same for 1981 and 1991. Amongst the social services variables, the inter-district variation has considerably increased for households using tap as a source of drinking water between 1981 and 1991. The co-efficient of variation shows an increase from 0.52 in 1981 to 0.60 in 1991. While the other two indicators showed a declining trend of inter-district variation. The decline in inter district variation regarding female literacy is marked from 1981 to 1991. In terms of economic indicators the inter-district variation has almost remained the same for the two points of interest for the study. The utility variable (institutional births) however, shows marked decrease in inter district variation from 1981 to 1991. The coefficient of variation shows a decline from 0.23 in 1981 to 0.08 in 1991. Thus we conclude that the inter-district

variation has increased for percentage households using tap as a source of drinking water(HHTWD) and doctor population ratio(RDRPLN). All the other variables show a declining inter district differentials. But sharp decline in inter-district variations is noticed for female literacy and percentage institutional births.

Table 4.17: **Measures of predictor variables showing inter district variation for 1981 - 91.**

Variable	year	Average	Min	Max	range	std dev	coef var
Health Services							
RB/lakh popln	1981	286.17	96.82	494.64	397.82	122.54	0.42
	1991	347.47	151.29	603.28	451.99	134.49	0.38
RMI/lakh popln	1981	16.70	9.93	26.37	16.44	5.39	0.32
	1991	17.96	10.72	28.28	17.56	5.60	0.31
RDr/ lakh popln	1981	32.58	16.63	48.88	32.25	10.06	0.30*
	1991	43.91	21.96	73.14	51.18	14.97	0.34
RPMW/lakh popln	1981	82.22	31.46	132.35	100.89	31.70	0.38
	1991	116.09	76.45	163.40	86.95	29.92	0.25
Social Services							
% FELIT	1981	65.73	51.55	79.35	27.80	9.13	0.14**
	1991	85.27	75.72	94.00	18.28	5.36	0.06
%HhWST	1981	18.25	10.82	30.53	19.71	5.80	0.31
	1991	51.76	26.79	67.39	40.60	13.48	0.26
%Hh TWD	1981	11.94	2.39	24.43	22.04	6.32	0.52*
	1991	17.73	5.77	45.51	39.74	10.68	0.60
Economic Services							
PCI(Rs)	1981	1508	1045	2017	972	283.12	0.18
	1991	1818	1091	2536	1445	356.62	0.19
%URB	1981	18.74	4.60*	39.56	34.96	10.58	0.56
	1991	26.38	3.41	48.79	45.38	14.77	0.55
Utilization of Services							
Inst Births	1981	74.05	40.74	95.10	54.36	17.49	0.23**
	1991	94.46	76.94	99.97	23.03	7.67	0.08

** sharp decline. * increase.

ANALYSIS

5.1. CORRELATION BETWEEN IMR,CMR AND PREDICTOR VARIABLES

Table 5.1 presents zero order correlation coefficient for IMR, CMR and change in trend with the 4 health services variables, 3 social services variables, 2 economic variables and 1 variable of utilization of services.

Table 5.1: **Zero order correlation coefficients between IMR, CMR and predictor variables.**

Variable	Infant mortality rate (IMR)		Child mortality rate (CMR)		Percentage change	
					IMR	CMR
	1981	1991	1981	1991		
RBPLN	.0976	-.0382	-.8821 ***	-.5097	-.0561	-.2833
RMIPLN	.1099	.0771	-.6738 *	-.2955	-.1648	.2657
RDRPLN	.0228	-.2356	-.8811 ***	-.7342 **	-.0984	.0329
RPMWPLN	.0002	.0735	-.8491 ***	-.2731	.0288	-.3028
FELIT (%)	-.2770	-.0831	-.9508 ***	-.6958 **	-.1938	-.6559*
HHWST(%)	-.3936	-.1861	-.7931 * *	-.6840 **	0584	-.4267
HHTWD(%)	.2014	-.1788	-.4183	-.3523	.3730	-.0032
PCI	.3929	-.1414	-.3971	-.2023	.1031	.3234
URBPLN(%)	-.5321	-.2097	-.4546	-.6206 *	.3345	-.0036
INSTB(%)	-.3132	-.0652	-.9644 ***	-.7406 **	-.2948	-.4927

*** p ≤. 001. ** p ≤ . 01. * p < . 05.

From Table 5.1, we infer that none of the determining variables had any significant correlation with IMR in 1981 as well as in 1991. Only four of the predictor variables demonstrate the expected negative sign of coefficients, in 1981. Percentage of urban population shows moderate negative correlation with IMR in 1981. In 1991, however nine of the determining variables have the expected negative sign. The results of these correlations demonstrate the narrowing range of inter-district variations between predictor variables and IMR, although weak in strength. However, in 1981 and 1991, the correlation coefficients of all the determining variables have the expected negative sign with CMR. In addition, all

the determining variables except per capita income and urban population have moderate to strong negative correlation with CMR for 1981 and 1991. The strongest correlation with CMR in 1981, is observed for institutional births(-0.964). and female literacy(-0.950). By 1991, we notice that all the coefficients with CMR demonstrate a reduction in strength of association, in comparison with 1981. The strongest negative correlations with CMR are observed for institutional births(-0.740) and ratio of doctor population (-0.734) and in 1991. In terms of change over time we observe that the sign of the correlation coefficients of only 5 of the determining variables have the expected negative direction with IMR and none of the variables show any significance. Similarly with change over time in CMR, the correlation coefficients of seven of the determining variables show the expected negative sign of direction. Only one determining variable viz. percentage female literacy, shows significance at 5% level with CMR over the decade. ANNEXURES V A, B and C presents the zero-order correlation coefficients between the predictor variables for 1981,1991 and change over time.

5.2. DETERMINANTS OF HEALTH STATUS INDICES (IMR and CMR).

Regression analysis is useful aid to understand the predictive relationships between the variables. The regression analysis provides us an opportunity to quantify the impact of specific independent variables on the dependent variable. Linear regression equations were used for this purpose. For testing the significance of the estimated regression coefficients, we have applied the students t - test and for testing whether a particular equation is best fit for the data or not we have applied

the F - test. The correlation coefficient r^2 provides the measure of the extent of variation of the outcome variable explained by the determining variables. One basic problem that we encountered in getting the best estimates of the variables is the problem of multi - collinearity. Before we, finally selected the explanatory variables to be included in the regression equation we examined the zero order correlation coefficient matrix. There are three explanatory variables selected to be included in regression equation representing the health, social and economic services. The criteria for selection of these variables is based on the highest zero- order correlation with IMR and CMR. We have estimated the step wise regression in each case and presented the results of only those equations with significant r squared. The first explanatory variable selected by us to be included in the equation is female literacy rate and we expect a negative sign for the regression coefficient. The second explanatory variable considered is percentage urban population as urbanization increases access to health care. We expect an negative regression coefficient for this variable too. The third explanatory variable considered for regression equation is the ratio of doctors per lakh population. We expect a negative sign for this regression coefficient. These three variables were based on their linkage to the research hypothesis (health service variables) as well as social and economic development in the state.

The regression equation used is as follows:

$Y = a+bx_1$ where X_1 = %FELIT (1981 and change over time)
RDRPLN (1991)

$Y = a+bx_1+bx_2$ where X_2 = %URBPLN(1981 and change over time)

% FELIT (1991)

$Y = a+bx_1+bx_2+bx_3$ where X_3 = RDRPLN (1981 and change over time)
%URBPLN(1991)

We have estimated the step wise forward regression in each case and presented the results in Table 5.2, of only those equations with significant r squared.

Table 5.2 **Results of step wise regression on health status indices.**

Y	Constant	X_1	X_2	X_3	R_2
CMR					
1981 F=84.78	209.62	-1.986 *** (.215)	-.193 (-.597)	-.189 (-.287)	.90
1991 F=11.69	65.40	- .417 ** (-.122)	-.325 (-.353)	-.395 (.089)	.53
change F=6.79	-24.76	- .490 * (.188)	-.201 (-.256)	-.066 (-.086)	.43

Figures in ( ) are standard error of Beta. *** p < . 001 . ** p < . 01. * p < .05 .

Due to non - availability of data for the years of interest in the study (1981 and 1991), we had to use the intra -polated data for health services variable inspite of the statistical limitation of possible change in degrees of freedom in multi-variate regression analysis

The results of step wise forward regression coefficients for IMR is not presented in Table 5.2 as the correlation coefficients of the determining variables with IMR were not found to be statistically significant to enter the step wise regression equation for 1981,1991 and change over time. This proves that none of the explanatory variables considered in the equation no longer effected the infant mortality during study period. It is interesting to note, that the same variables which proved to be insignificant with IMR were statistically significant with CMR for the same points of time. All the regression coefficients for CMR, had the expected negative sign for all the 3 explanatory variables. In 1981, female literacy was a major determining factor of CMR with a p value of .000. Female literacy along with urban population proved to be significant at 10% level in 1981. The three explanatory variables together

explain 90% of the inter-district variance in child mortality in 1981. However, the major determining factor explaining CMR in 1991 was ratio of doctors per lakh population, which shows a significant p of .006. The three variables explain 53% of inter district variation in child mortality in 1991. In terms of change over time(1981 - 1991) female literacy proves to be the single most major determinant of child mortality with a significance at 5%. All the 3 explanatory variables together explain 43% of inter district variation in child mortality rates over a period of time.

DISSCUSSION

Inter district variations and child mortality rate: Analysis of secondary data shows that the decline in inter-district variation for CMR between 1981 and 1991 was not as sharp as for IMR. The strongest correlations with CMR in 1981 were observed for female literacy and institutionalized births suggesting that there is direct relationship with CMR. Significant effects were observed with CMR for the following determining variables (female literacy in1981 and for change over time and ratio of doctors per lakh population in 1991). It is necessary to note, that there was a shift in the determining variables during the two points time in our study . In 1981, female literacy emerged as the strongest predictor of child mortality in Kerala. However, by 1991 the impact of effect of female literacy had reduced and ratio of doctors per lakh population emerged as the strongest predictor of child mortality. This may be due to the fact that the number of doctors nearly doubled by 1991 across all the districts of Kerala especially in private sector. The impact of increased availability of doctors was also reflected in increasing utilization of services (institutional births). Hence, female literacy, ratio of doctors to population and institutional births were all highly correlated. However, factors such as female literacy may have had a direct effect on child mortality, as well as an indirect effect operating, for example, through the selected manpower variable. The decreasing strength of all significant correlations with CMR between 1981 and 1991 suggests that the relationship between these factors and CMR decreases in strength as the inter-district variation declines. This finding implies that the relative importance of variables changes over time. As the health status indices improve, their relationship

to the variables that were important in the initial improvement becomes weaker and other factors emerge as stronger determinants.

Inter -district variations and infant mortality rate: One of the most interesting findings of this study was the lack of relationship between the predictor (determinant) variables and IMR in 1981, 1991 and for change over time. This is in spite of the fact that the inter-district variation in IMR had markedly narrowed down during the two points of time. It is possible that the required threshold level at which these determining variables are significantly associated with IMR, had already been reached by 1981 itself. It may be that the impact of these factors'on the IMR has decreased by 1981, by which time the major improvements in IMR, had already occurred. One should also note here that the average percentage of neonatal mortality in the state, contributing to the total infant mortality was 43.94 % in 1981 and it has risen to 86.35% by 1991 [33,34]. This denotes that with a reduction in IMR, the contribution of neonatal deaths to total infant deaths increases. It is well established fact that as deaths become progressively rarer more sophisticated techniques are required to describe variations in person, place and time which may throw light on the underlying causes of neo-natal mortality [35]. Since none of the determining factors considered for the study show any significant assocoations with IMR, it is likely that there may be other determining factors (such as percentage of children vaccinated, breast feeding, and nutrition status of children) which need to be explored in further study. It may also be noted here that when the variables are highly correlated within themselves as in the present case, it is difficult

to demonstrate separate effects for a given variable. The reason as to why female literacy is not a significant predictor of IMR and is a less significant predictor of CMR in 1991 may be that, much of the literacy given in Idukki, Wyanad and Malappuram districts is due to total literacy campaigns and not education per se. Our study results are at variance from that reported by one of the earlier studies [30] regarding the impact of female literacy at district level on IMR. One possible explaination is that, unlike the other study, chose of infant mortality (infants dying below 1 year of age(q1)) and not infants dying below 2 years of age (q2) as the outcome event of interest .

The inter-district variation of health service variables has been decreasing except for number of doctors per lakh of population. This may be due to greater availability of doctors in districts where teaching hospitals are located, i.e. Thiruvanathapuram, Kottayam, Thrissur, Kozhikode and Alleppey districts. The increasing number of health personnel (both private and public sector) in the state has provided opportunity for, increasing utilisation of health services, thus reducing the inter-district variation in utilisation. The results of this investigation suggest that the availability of water supply did not improve significantly from 1981 -1991 so as to contribute to improvements in health status indices . The contribution of female literacy as a primary predictor of child mortality amongst the social service variables has been quite evident in reducing the inter- district variation in the state of Kerala over the decade.

LIMITATIONS

7. LIMITATIONS OF THE STUDY The health indices used for the study are both mortality based. The impact of the variables studied on the levels of morbidity and disability in the districts of Kerala have not been investigated. The estimates of health status indicators and determining variables include large time lag and errors of estimation and data collection. Our major statistical limitation for this study is the small number of districts in Kerala and the problem of multi-collinearity. The sources for IMR and CMR, are based on indirect methods of estimation, thus giving higher rates than the Sample Registration Survey (SRS) due to possible inaccuracies in the reporting of age, the number of children born and surviving, the small number of events reported and other factors. The sources used for the study are the only available sources for conducting such a study on inter-district variation in Kerala inspite of this limitation . As the state health services department does not have a manpower division at present, the study is based on indirect sources of data for government sector and the private sector.

Directions for further research: The results of the present study would clearly be more reliable if the necessary data could be improved in the quality and extent . One of the obvious extention of the present study would be a systematic attempt to improve the data base. Rather than an individual researcher doing, it would be more appropriate if the state government with its resources undertakes such a task than possibly the research outcome can be better utilized. This would provide scope for developing models for more elaborate research in each sub-system which cannot be provided with the statistical model and its evident limitations.

CONCLUSION

8.CONCLUSION

Having reviewed the available data it is possible to postulate the following conclusions. The determinants influencing infant and child mortality in the state of Kerala have changed over time. Certain determining variables such as female literacy seem to have a strong initial influence on child mortality rate and later act as a catalyst for change by helping to increase the strength of relationship of other determining factors, for example, doctor population and institutionalized births. This study clearly shows that the health policy, should be flexible enough to account for the new and emerging determinants of infant and child mortality over time. These changes observed in the relationships of predictor variables and health status indices are related to the changes in inter-district variation. A state-level focus may be effective in making initial steps towards progress in health status indices at macro level. However, once the macro level change is achieved, the inter-district variation becomes more prominent. The emerging dimension of the Kerala health scenario is that planning at a local level may be effective at reducing inter-district variation once macro- level changes have occurred. Thus, the consideration of health status indicators at a disaggregated level is essential for planning and evaluating health services and for monitoring changes in health of population over time across regions.

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ANNEXURES

ANNEXURE I

Selection of health status indices

Infant Mortality Rate: For the purpose of this study IMR is taken as an outcome variable. The reason for taking such an indicator is that it is highly correlated with other age specific mortality rates and can serve as a proxy of life expectancy or any other index of overall mortality. Secondly, IMR is also sensitive to socio-economic, environmental and health interventions prevailing in the community in terms of availability, utilization and effectiveness of health care. As an indicator, it reflects the current level of health inputs, although it limitation is it refers to a particular age group.

Child Mortality Rate: Though Life expectancy at birth would have been a better outcome variable for measuring health status but due to non availability of data for the same by districts we decided to include child mortality rate. The logic behind consideration of this indicator is that it pertains to reflect the health status of children in five different age groups. The interaction of the children with public health programmes, social services and economic indicators is more for these age groups. Thus projecting about the linkages of development with health status of people.

Selection of predictor variables

The predictor (determinant) variables selected for the study are those for which relationship with health can plausibly be argued at micro level and tested at macro level. The 4 sets of variables grouped here are:

a. Health Services Variables:

1. Ratio of beds per lakh population:(RBPLN) Availability of total beds(private and government) per lakh population in each district gives an idea of health services supply during the period under study.

2. **Ratio of medical institution per lakh population:(RMIPLN)**: The total medical institutions (private and government) available in the districts per lakh population gives us an idea about the distribution of medical institutions across districts. This indicator shows about the availability of medical care infrastructure for health care in the districts.

3. **Ratio of doctors per lakh population:(RDRPLN)** This indicator shows the position of total allopathic doctors engaged in both government and private sector across districts in terms of population. This is a crucial indicator for the study as the state shows the largest increase in doctor population for any period in Kerala. Lack of studies on distribution of doctors and manpower planning further highlights the necessity of including this indicator in the study.

4. **Para medical workers ratio (RPMWPn)** : The definition of para medical worker is the same as defined by the sources used and includes para medical workers in both public and private sectors. This variable is chosen for the study as para medical workers represent those sub set of state health services personnel who, reach the population at the sub-unit level(household). The direct contact of paramedical workers with households may enable the children's guardians to understand what measures need to be taken for infant or child health. Hence, the number of paramedical workers reflects the level of outreach services in the districts.

b. Social Services variables :

1. **Female literacy rate**: **(FELIT)** Since data on female education (school enrollment ratio) at district level is not available, female literacy rates were taken as proxy for female education across districts. The high rates of female literacy in the state of Kerala and the role of female literacy on health status variables and socio economic development in the state has been well documented by the earlier studies. Hence, it becomes necessary to study the impact of female literacy on IMR and CMR for this study time period.

2. **Percentage households using tap as a source of drinking water (HHWTD)** : As we are looking into infant and child mortality, the major causes of death in these age groups are attributed to diarrhoeal diseases and pneumonia during the 1980's.(Bulletin of Vital Statistics of Kerala 1981). In this context it was felt necessary to investigate the source of water supply to the households in the state by district, i.e. to assess the number of households having access to safe drinking water and its impact on infant and child mortality.

3. **Percentage households having water sealed toilets (HHWST)** : This variable was chosen to understand its role, in reduction of deaths caused by water borne diseases amongst infants and children as a result of improvements in environmental sanitation during 1981 - 1991 in different districts of Kerala.

c. Economic Variables: Variables intrinsic to economic changes.

1. **Per capita income(Rs): (PCI)** District per capita income may not be a true reflection of the district income in Kerala .As these figures do not account for huge remittances from the gulf countries into the district. However, due to lack of data on gulf remittances for the two points of time under study inspite of the limitation of taking district per-capita income

we decided to include the secondary data available on the same for studying the impact on IMR and CMR for the two points of time.

2. **Percentage of urban population (URBPLN) :** Since the population urban reflects changes in the economic prosperity of the districts. This variable is considered to be of importance as a parallel variable to per capita income as it accounts for the increasing access to health care and change in life styles, thus representing growth in income levels indirectly. This variable is calculated as percentage of population urban to total population in the districts.

d. ***Utilization of health services variable**: This variable is an outcome of change over the period and reflects the utilisation of health services, and improvements in socio-economic situation in the state.*

1. **INSTITUTIONAL BIRTHS:(INSTB)** This variable is of immense significance because it indicates about the changes associated with access to health care infrastructure, in terms of, education ,transportation, economic prosperity and urbanization .

ANNEXURE II.

Definition and sources used in the study

VARIABLE	YEAR	DEFINITION	DATA SOURCE
Health status indicators:			
IMR	1981	No of deaths below 1 year of age / 1000 live births. (estimated on the basis of children ever born and children surviving by using Brass and Trussels technique).	Child mortality estimates of Kerala India Reg. general 1988, occassional paper No 5 of 1988. Controller of publications. New Delhi.
	1991	do	Working paper. Long term implications of low fertility in Kerala . Rajan I.S. and Zachariah.K.C.
CMR	1981	No of deaths below 5yrs of age / 1000 live births. (estimated using same method as for IMR).	same as for 1981 IMR.
	1991	do	same as for 1991 IMR.
Predictor variables:			
Availability Beds (Govt)	1981	Total beds in Govt. medical (allopathic) institutions for medical care.	Govt. of Kerala. statistics for planning 1983. Dept. of econ. and statistics. Trivandrum.
	1991	do	Administrative report - Directorate of Health Services. Trivandrum.
(Pvt)	1985	Total beds in private medical (allopathic) institutions for medical care.	Govt. of Kerala - report on survey of private medical institutions in Kerala.1985. Dept. of economics and statistics. Trivandrum. 1986.
	1995	do	Govt. of Kerala- report on survey of private medical institutions in Kerala 1995 . Dept. of economics and statistics. Trivandrum 1996(in press)
Medical institutions (Govt)	1981	All medical inst.(allopathic) under the DHS(Hospitals,PHC CHC, Dispensaries, MCH -	Govt of Kerala .Statistics for Planning 1983. Dept of econ. and statistics T rivandrum.

VARIABLE	YEAR	DEFINITION	DATA SOURCE
		centres, TB centres, clinics includes Grants in aid centres).	
	1991	do	Statistics for planning. Dept of econ. and statistics. TVM 1993.
do	1985	Institution run by individuals (Private) or organisations other than Govt. Those receiving grants considered asPvt inst.	Govt of Kerala - report on survey of pvt. med. inst. in Kerala 1985. Dept of econ. and statistics. TVM. 1986.
	1995	do	Govt of Kerala - report on survey of pvt. medical institutions in Kerala 1995. Dept of econ. and statistics. TVM. 1996.
Doctors (Govt)	1979 1982	Qualified medical graduates engaged under DHS* as medical officers in various districts and those doctors engaged in teaching post in medical colleges.	Govt of Kerala -study on migration medical and para medical personnel from health services Manpower study series No 46. Manpower division Dept of econ. and statistics. Trivandrum. May 1984.
	1991	do	Directorate of health services 1991. Manpower register (unpublished).
		Doctors engaged in medical colleges for teaching purposes in clinical and non clinical posts and under the control of Directorate of Medical Education(DME).	Kerala Government Medical Colleges Teachers Association 1991. TVM. (unpublished document).
do (Private)	1985	Any person in the institution authorized to do diagnosis in illness, prescribe medicine to conduct surgery etc. is considered a doctor for the purpose of census. Includes paid/ unpaid/ full time or part time. Verification of whether he/she has prescribed qualifica-	Govt of Kerala. Report on survey of pvt medical institutions in Kerala. 1986. Dept. of econ. and statistics. Trivandrum.

VARIABLE	YEAR	DEFINITION	DATA SOURCE
		tions or possessed valid registration was not assessed.	
	1995	do	Govt of Kerala. Report on survey of Pvt. medical inst. in Kerala 1995. Dept of econ. and statistics TVM. March 1996. (In press).
Para medical workers(Govt)	1981	Nurses,Pharmacists and lab tech.	same as for govt doctors in 1981.
	1991	do	same as for govt doctors in 1991.
do (Pvt)	1981	do	same as for other health services variables in Private sector 1981
	1991	do	same as for other health services variables in Private sector 1991.
Female literacy rate	1981	Females above the age of seven who can read and write with under standing in any language is considered a literate. Person need not have passed any formal education.	Census of India - Kerala 1981. Paper 3. series 10 Registrar General of India.
	1991	do	Census of India - Kerala 1991 Registrar General of India.
Per capita income.	1980-81 1990-91	District income includes all income originating within districts irrespective of fact that income accrues to persons inside or out side the district.	Table : 15.7(6) Govt of Kerala Statistics for planning 1993 Dept of econ. and statistics. Trivandrum.
Water Sealed Toilets	1980	Availability of water sealed toilets whether within the houses within the premises although outside the house premises is also considered .	Govt of Kerala - survey on housing and emplyt. 1980. Directorate of econ. and statistics Trivandrum.
	1991	Households having toilet facility categorised whether the house is own, rented or others. Includes rural and urban.	Census of India 1991, series 12 Kerala - tables on houses and household amenities Part VII. Table No: H5. Reg. general of India.
Drinking Water Facility	1981	Households using taps,hand pumps or tube wells situated within or out side the premises that household is considered to have access to safe. drinking water.	Census of India 1981. Series 10. Kerala. Part VIII A and B. House hold tables. HH7. Household by source of drinking water. Reg. general of India.

VARIABLE	YEAR	DEFINITION	DATA SOURCE
	1991	do	Census of India 1991. Series 12. Kerala Part VII . tables on houses and household amenities. Table H5 households classified by source of drinking water availability, electricity and toilet facility.
Urban population	1981	Population of over 5000 Those with a municipality corporation,cantonment board and those with a population density of greater than1000 per sq.mile .Also includes those with at least 75% of male labour force engaged in non- agricultural sector. Percentage of urban population to the total population of districts.	Census of India 1991. series 12 Kerala paper 2 of 1991, provisional population totals - rural urban composition and worker distribution.
	1991	do	do
Institutional Births	1981	Births that have taken place in medical institutions or at home under the guidance of doctor or trained nurse.	Govt. of Kerala. Vital statistics 1981.Dept of economics and and statistics. Trivandrum.
	1991	do	Govt. of Kerala. Vital statistics Bulletin No 56,. Dept of economics and statistics . Trivandrum, 1992.

* Directorate of health services.

ANNEXURE III

Population by district in Kerala in 1981 and 1991.

DISTRICT	Population in persons	
	1981	1991
KSR	*	1072000
KNR	1931000	2252000
WYN	554000	672000
KZK	2245000	2620000
MLPM	2403000	3096000
PLKD	2044000	2382000
TRCH	2440000	2737000
ERNK	2535000	2817000
IDK	969000	1078000
KTM	1697000	1188000
ALP	1866000	2001000
PTHN	**	1828000
KLM	2193000	2408000
TVM	2596000	2947000
Kerala	25454000	29098000

*1981: Kasargod Taluk population 873000.
**1981: Pathanamthita Taluk population 1108000.

Sources: Census of India.Kerala. Provisional population totals. 1981. Registrar General of India. Census of India. Kerala. Provisional population Totals 1991. Registrar General of India.

ANNEXURE IV

Total number of households by districts in Kerala state in 1981 and 1991

Districts	Total number of households		
	1981*	1981	1991
Northern districts			
KSR	NA	NA	178175
KNR	430000	438080	362255
WYN	NA	101400	132025
KZK	390000	359769	444740
MLPM	340000	367180	469405
PLGT	340000	368505	440770
Southern districts			
TRCH	393000	416310	512735
ERNK	401000	437580	535735
IDK	168000	184795	232870
KTM	274000	293195	354310
ALP	405000	428945	397750
PTHN	NA	NA	254140
KLM	480000	512980	479265
TVM	445000	489395	596500
Kerala	**4066000**	**4398130**	**5340675**

Sources: *1980:Govt. of Kerala - survey on housing and employment.1980. Directorate of economics and statistics.Trivandrum. 1981: Census of India.1981. Series 10.Kerala.Part VIII Aand B. Household tables 1991: Census of India 1991. Series 12. Kerala .Part VII. Houses and household tables.

Annexure V

A . Zero-order correlation coefficients between predictor variables in 1981.

	1	2	3	4	5	6	7	8	9	10
1	1	0.8256	0.9675	0.9511	0.879	0.7229	0.6502	0.5766	0.2662	0.8146
2		1	0.8668	0.7852	0.7557	0.4037	0.4455	0.3761	-0.0926	0.5727
3			1	0.9037	0.8826	0.7022	0.6512	0.4919	0.2944	0.8118
4				1	0.8720	0.7516	0.6223	0.5112	0.2456	0.7842
5					1	0.7828	0.3402	0.2849	0.2918	0.8811
6						1	0.6097	0.4541	0.7349	0.8267
7							1	0.7356	0.5157	0.4761
8								1	0.4171	0.4837
9									1	0.5836
10										1

* **1.RBPLN** - ratio of beds per lakh population. **2.RMIPLN** - ratio of medical institutions per lakh population. **3.RDRPLN** - ratio of doctors per lakh population. **4.RPMWPN** - ratio of para medical workers per lakh population. **5. FELIT** - % female literacy **6. HHWST - %** households with water sealed toilets **7. HHTWD**. - % households using tap as source of drinking water. **8. PCI** - district per capita income **9.URBPLN - %** urban population **10. INSTB - %** institutional births.

Annexure V

B. Zero Order Correlation coefficients between predictor variables in 1991

	1	2	3	4	5	6	7	8	9	10
1	1	0.8354	0.8838	0.8993	0.6646	0.4246	0.5350	0.5247	0.1195	0.5769
2		1	0.6772	0.8819	0.5035	0.0085	0.3891	0.5935	-0.1016	0.4086
3			1	0.6887	0.7619	0.6478	0.5624	0.3650	0.3883	0.6891
4				1	0.4141	0.1302	0.5648	0.6883	-0.0445	0.4410
5					1	0.7589	0.2629	0.1104	0.4271	0.5961
6						1	0.3822	-0.0146	0.6691	0.5692
7							1	0.4815	0.4340	0.3946
8								1	0.3478	0.5389
9									1	0.6204
10										1

* **1.RBPLN** - ratio of beds per lakh population. **2.RMIPLN** - ratio of medical institutions per lakh population. **3.RDRPLN** - ratio of doctors per lakh population. **4.RPMWPN** - ratio of para medical workers per lakh population. **5. FELIT** - % female literacy **6. HHWST - %** households with water sealed toilets **7. HHTWD**. - % households using tap as source of drinking water. **8. PCI** - district per capita income **9.URBPLN - %** urban population **10. INSTB - %** institutional births.

Annexure V

C.Zero order correlation coeffiicient between predictor variables in terms of change over time.

	1	2	3	4	5	6	7	8	9	10
1	1	-0.0009	0.3581	0.2465	0.5402	0.5172	0.1958	-0.2478	-0.0394	0.6414
2		1	0.4769	0.2592	0.0713	- 0.5183	-0.0281	-0.4220	-0.1722	-0.0752
3			1	-0.3173	-0.1489	- 0.1581	-0.192	0.0440	0.1306	-0.2120
4				1	0.8109	0.0947	0.7601	-0.9089	-0.2615	0.6242
5					1	0.2359	0.6405	-0.7948	-0.2784	0.9053
6						1	0.3636	0.0363	0.0825	0.4122
7							1	-0.6957	-0.1800	0.4339
8								1	0.4548	-0.5550
9									1	-0.2375
10										1

* **1.RBPLN** - ratio of beds per lakh population. **2.RMIPLN** - ratio of medical institutions per lakh population. **3.RDRPLN** - ratio of doctors per lakh population. **4.RPMWPN** - ratio of para medical workers per lakh population. **5. FELIT** - % female literacy **6. HHWST - %** households with water sealed toilets **7. HHTWD**. - % households using tap as source of drinking water. **8. PCI** - district per capita income **9.URBPLN - %** urban population **10. INSTB - %** institutional births.