Is there a Kerala model of health?
A comparison of infant and child health related indicators of Kerala with other South Indian states

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ABSTRACT

Recent UNICEF report on the health indicators of India mirror poor maternal and child health conditions, along with practices of early marriage and childbirth during adolescence. At the same time the southern state of Kerala stand out as a beacon of hope. Most of the maternal and child health related indicators of Kerala are still comparable to many developed countries, even though the state's per capita income is low in comparison. The purpose of this paper is to examine the determinants of Infant and child mortality in South India with a comparison to Kerala by using National Family and Health Survey round 3 (NFHS 3) data of 2005-06. Econometrics models are used to assess the determinants. In the analysis all the determinants of infant and child mortality are considered for all the four south Indian states. The mortality of infant and child is found to depend on environmental, biological, socio- economic and behavioural factors. An interesting finding is, the employment status of women is proved to be a significant determinant of child mortality. Children of employed mothers are more vulnerable to mortality than non employed mothers. The educational status of women also showed a significant impact on the survival of their infants and children. The biological and behavioral factors also proved as significant determinant of infant and child mortality in South India.

INTRODUCTION

Kerala model of health refers to the achievement of a southern Indian state of Kerala in high material quality of health related indicators that are comparable to many developed countries, even though the state's per capita income is low in comparison. Recently Kerala model of health has got many criticisms because of emergence of some communicable diseases, high morbidity statistics however even now Kerala stand first among all Indian states in terms of maternal and child health related indicators. This paper examines the current scenario of Kerala and other south Indian sates by looking the determinants of infant mortality rate (IMR) and child mortality rate (CMR). Most of the demography and health literatures use infant and child mortality variables as a measuring tool of health status of a country. Using data on changes in those determinants, the researcher examines the factors behind falling infant and child mortality in south India and the mortality differential between states.

MATERIALS AND METHODS

Data: The data used for analysis in this study is National Family and Health Survey round 3 of 2005-06[1]. Different organizations collected data for NFHS under the coordination of International Institute of Population Sciences (IIPS) Mumbai.

These surveys provide data on fertility, family planning, maternal and child health, nutrition and infant and child mortality and related issues. The household sample survey covered over nearly 99% of country's population. The sample covers 124,385 ever married women aged between 15 and 49 were interviewed in local languages in India out of which 22,621 are from south India.

The setting of the study area: The field of investigation for the study is south Indian states. South India is a socio-political region of India that comprises the four Indian states of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. This region includes the entire Indian Peninsula, south of the Vindhya ranges. The Narmada and Mahanadi rivers form the northern boundaries of the region, while the Arabian sea, Indian ocean and the Bay of Bengal surround the peninsula in the west, south and east respectively.

Methodology: In order to examine the determinants of infant and child mortality in south India, regression model is used.

Operational Definitions and Concepts: All mortality rates presented in this study are probabilities of dying between two exact ages.

Infant Mortality: The probability of dying between birth and exact age one.

Child Mortality: The probability of dying between exact age one and five

Infant and Child Mortality in South India an overview

This section examines the IMR and CMR in South Indian states and a comparison also made with all India average. During 2005-06 IMR and CMR in all South Indian states are less than Indian average (Table 1). Kerala is the lowest with an IMR of 15.3 and CMR of 1, Andhra Pradesh is the highest with 53.5 IMR and in case of CMR Karnataka stands first with 12.1.

Determinants of Infant and Child Mortality

The selection of determinants of IMR and CMR is based on review of previous studies [1, 2]. The literatures have found four major groups of determinants of IMR and CMR viz; biological, behavioral, environmental, and socio-economic factors.

i) Biological Factors

The biological factors that influence IMR and CMR are: multiple births, mother's age, length of preceding birth interval and sex of the child. The higher mortality of children from multiple births, especially during the neonatal period (first month of life), is common in areas of the developing world [2]. A detailed examination of biological factors is given under.

A) Birth Interval

Birth interval is defined as the length of time between two successive live births that indicate the pace of childbearing. Short birth intervals may adversely affect mother's health and her children's chances of survival. Recent research has shown that the optimal birth interval is 3-5 years for reducing neonatal and infant mortality [3] and achieving optimal nutrition outcomes. Table 2 depicts *median number of months since preceding birth* during five years preceding the survey by birth interval. The median birth interval in India is 31.1% and in Kerala it is 41.2%, which is the highest among all south Indian states. In demography literature the optimal birth interval is 36-59 months. The median birth interval in Andhra Pradesh, Karnataka and Tamil Nadu ranges between a narrow margin of 30.3 to 31.4 months which is less than the proposed optimal birth interval.

B) Reported Birth Weight

Complications at birth and low birth weight are considered among the most important determinants of higher risk of death of twins [4]. Table 2 show the percentage distribution of births by reported birth weight. It is based on either a written record or the mother's recall. All the four south Indian state's birth weights are somewhat similar to Indian average. Above 80% of babies in all states have 2.5 kg or more weights at the time of birth. Nearly 20% are under weighted at the time of birth.

C) Mother's Age at Birth and Fertility Rates

Table 2 shows the extent of teenage pregnancy and motherhood in south India. The marriage of girls at young ages leads to teenage pregnancy and motherhood. Young women who become pregnant and have births experience a number of health, social, economic and emotional problems. In addition to the relatively high level of pregnancy complications among young mothers because of physiological immaturity, inexperience associated with child care practices also influences maternal and infant health [1].

D) Birth Order

Children born after a short interval to the previous birth, generally present higher mortality rates. The key factor determining this relationship is the physical and nutritional depletion of mothers [5]. The complex relationship between birth order and mortality is not well understood. In general, mortality is higher among first birth, which is usually explained by the observation that many mothers have their first child before having reached physical and reproductive maturity [4]. For children, rather than infants, there is often a higher risk associated with being a higher birth order child.

ii) Behavioural Factors

This subsection explains the behavioral factors that determine infant and child mortality. According to UNICEF [6], 73% of deaths of children under five are a consequence of low-cost treatable diseases. Deaths caused by respiratory diseases, diarrhoea, measles, tetanus and pertussis, which account for more than 60 % of all deaths of children in developing countries, could be easily avoided by the use of antibiotics, immunization and Oral Rehydration Salts(ORS). Determinants coming under this category are listed in detail in table 2 and 3.

iii) Environmental Factors

Environmental factors included in the present analysis are toilet facility, water sources and fuel used for cooking. Better access to all these basic amenities are not only an important measure of the socio economic status of the household but also fundamental to the health of its members. Absence of these environmental factors contributes to different types of diseases. In the present study the researcher used the absence of an accessible source of water, and use of surface or rainwater, as a general sign of water contamination through which various diseases can be transmitted. Finally, it is considered that the use of unsafe fuel like dung, wood or coal for cooking as a possible concurring cause in the production of respiratory diseases. Although such a variable has not commonly been used, indoor air

TABLE 1 : Infant and child mortality in South India 2005-2006

States	Infant Mortality 2005-06	Child Mortality 2005-06
All India	**57.0**	**18.4**
Andhra Pradesh	53.5	10.2
Karnataka	43.2	12.1
Kerala	15.3	1.0
Tamil Nadu	30.4	5.3

Source: NFHS 3

NFHS 3 wealth index is based on the following 33 assets and housing characteristics: household electrification ,type of windows, drinking water sources, type of toilet facility ,type of flooring, material of exterior walls, type of roofing, cooking fuel, house ownership, number of members per sleeping room, ownership of a bank or post office account, mattress, a pressure cooker ,a chair, a cot/bed, a table, an electric fan, a radio/transistor, a black and white TV, a colour TV, a sewing machine, a mobile phone, any other telephone, a computer, a refrigerator ,a watch or clock ,a bicycle, a motor cycle/scooter, an animal drawn cart, a car, a water pump, a tresher, and a tractor
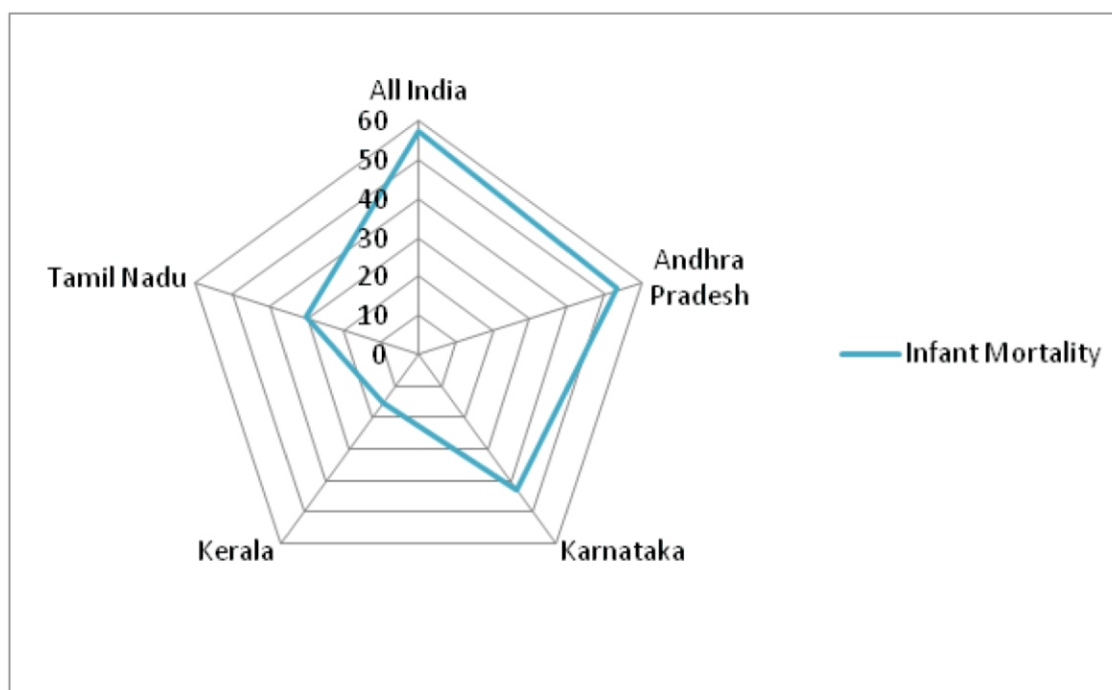
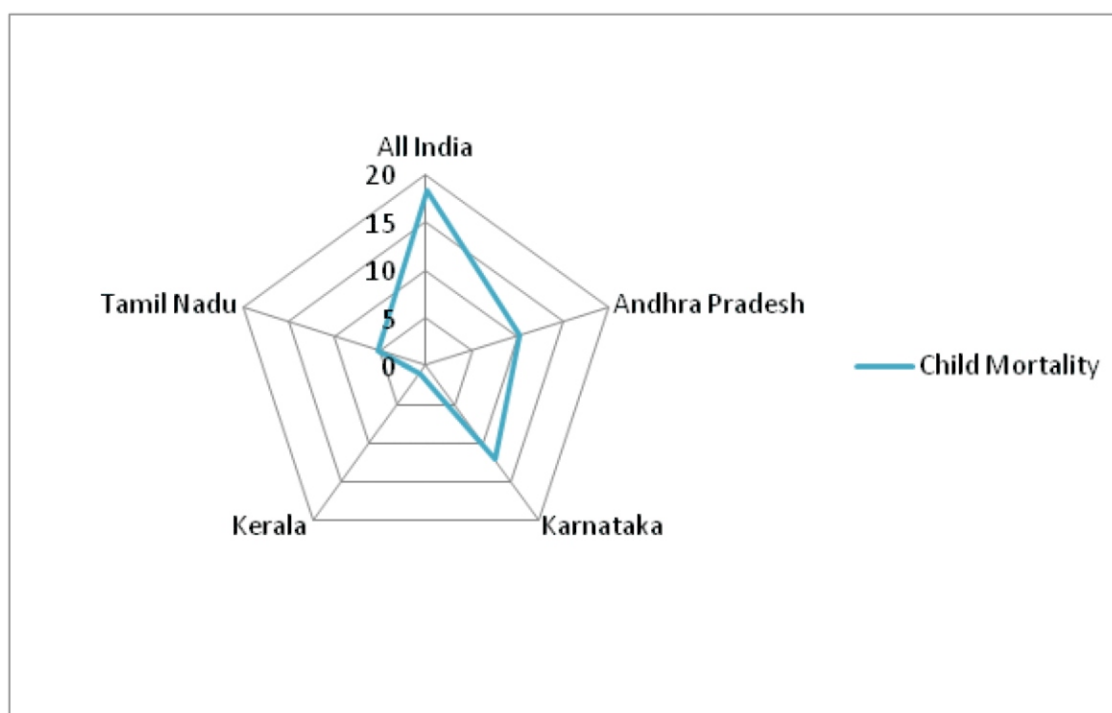**FIGURE 1** : Infant mortality in South India 2005-2006

FIGURE 2 : Child mortality in South India 2005-2006

quality is particularly relevant in households with small houses and room for cooking.

iv) Socio - Economic Factors

The socio-economic factors included here are mother's education and economic wellbeing. The correlation between mother's education and child mortality is well documented in a large number of studies and for various countries. Children of illiterate women have a much higher probability of dying at all ages and the older the child, the greater the difference in mortality between mothers of different educational levels [4].

The wealth indicator used here is a simple score index based on the possession of durable goods. The index is obtained by summing dummy variables representing the ownership of a given good, scaled to one divided by the number of goods used in the index. In order to assess the economic status, a wealth index is

TABLE 2 : IMR and CMR determinants in South India, 2005-2006

States	Median number of months since preceding birth	Birth weight in percentage		Total Fertility Rate(TFR)	Teenage pregnancy and motherhood		Percentage of children age 12-23 months who received specific vaccines		Prevalence and treatment of symptoms of ARI in south India		
		Less than 2.5 KG	2.5 KG or more		% of teenage girls (15-19) have had a live birth	% of teenage girls (15-19) are pregnant with first Child	All basic vaccinations[1]	No vacci-nations	Children under five with symptoms of ARI[2]	For whom the treatment was sought from a health facility or provider	Who received antibiotics
India	**31.1**	**21.5**	**78.5**	**2.68**	**12.1**	**3.9**	**43.5**	**5.1**	**5.8**	**69.0**	**12.5**
Andhra Pradesh	31.4	19.4	80.6	1.79	12.7	5.4	46.0	3.8	2.0	58.5	35.3
Karnataka	30.3	18.7	81.3	2.07	12.8	4.3	55.0	6.9	1.7	68.9	27.3
Kerala	41.2	16.1	83.9	1.93	2.9	2.9	75.3	1.8	2.7	88.8	33.2
Tamil Nadu	31.4	17.2	82.8	1.80	4.8	2.9	80.9	0.0	3.7	75.3	6.5

Source: NFHS 3

1 BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth)
2 Symptoms of ARI (cough accompanied by short, rapid breathing which was chest-related) are considered a proxy for pneumonia

TABLE 2 : IMR and CMR determinants in South India, 2005-2006

State	Antenatal care provider				Antenatal care visits		Maternal care indicators			ORS and breastfeeding	
	Doctor	ANM[1]/Nurse/Midwife/LHV[2]	Other	No One	At least one ANC visit	Three or more ANC visits	Who received all recommended types of antenatal care	Births delivered in a health facility	Deliveries assisted by health personnel	Percentage of women who know about ORS packets	Ever breastfed
India	**50.2**	**23**	**3.9**	**22.8**	**76.4**	**52**	**15**	**38.7**	**46.6**	**73.0**	**95.7**
Andhra Pradesh	87.5	6.4	0.7	5.2	94.3	85.4	28.2	64.4	74.9	66.9	95.5
Karnataka	79.1	9.6	1.6	9.4	89.3	79.5	29.6	64.7	69.7	71.9	96.3
Kerala	98.1	0.5	1.2	0.1	94.4	93.6	63.6	99.3	99.4	90.3	97.4
Tamil Nadu	83.6	14.3	1.0	1.1	98.6	95.9	34	87.8	90.6	74.2	94.5

Source: NFHS 3

3 Auxiliary Nurse Midwife
4 Lady Health Visitor

TABLE 4 : Regression result of infant mortality determinants in South India.

Explanatory Variables	Infant Mortality*(Dependent Variable)*			
	Andhra Pradesh	**Karnataka**	**Kerala**	**Tamil Nadu**
SOCIO ECONOMIC FACTORS				
Mother's Employment				
Not employed	rc	rc	rc	rc
Employed	1.06**	1.04**	1.01**	1.05**
Mothers Educational Status				
Has no education	rc	rc	rc	rc
Has primary education	0.77*	0.67*	0.79**	0.86*
Has secondary education	0.65**	0.87**	0.75*	0.76**
Economic Status				
Wealth Quintiles third or higher	rc	rc	rc	rc
Wealth Quintiles Second or Low	1.06	1.08	1.05	1.04
ENVIRONMENTAL FACTORS				
Unsafe Water	0.62	0.78	0.99	0.98
Unsafe Sanitation	0.65	1.01	0.79	0.88
Unsafe Fuel	0.87	0.67	0.87	0.65
BIOLOGICAL FACTORS				
Multiple Birth	5.37*	5.11*	4.19*	4.88*
Mothers Age at birth of child				
< 20 years	rc	rc	rc	rc
20-34 years	078	0.66	0.79	0.71
35 or more	0.66**	0.98**	0.77**	0.84**
Birth interval				
24 or more months	rc	rc	Rc	rc
< 24 months	1.93*	1.57*	1.66*	1.76*
Birth Order and presence of same sex siblings at birth				

Explanatory Variables	Infant Mortality *(Dependent Variable)*			
	Andhra Pradesh	**Karnataka**	**Kerala**	**Tamil Nadu**
Birth order 1	1.70**	1.69**	1.45*	1.32**
Birth order 2 or 3 with no same sex siblings	rc	rc	Rc	rc
Birth order 2 or 3 with same sex siblings	0.97	0.78	0.86	0.84
Birth order 4 or higher with no same sex siblings	1.05	1.08	1.00	1.76
Birth order 4 or higher with same sex siblings	1.49**	1.07**	1.02**	1.22**
Sex of child				
Male	rc	rc	rc	rc
Female	0.78	0.77	0.88	0.76
BEHAVIOURAL FACTORS				
Two or more tetanus injections	0.67**	0.75**	0.69*	0.64**
No antenatal visits	rc	rc	rc	rc
Antenatal Visits	0.87*	0.85**	0.90*	0.83**
Never Breastfed	1.67*	1.65**	1.66*	1.97**
Wald Chi square	144.24	145.0	143.9	143.1

* Significance at 5% level.   ** Significance at 10% level rc- reference category

TABLE 5 : Regression result of child mortality determinants in South India.

Explanatory Variables	Child Mortality *(Dependent Variable)*			
	Andhra Pradesh	**Karnataka**	**Kerala**	**Tamil Nadu**
SOCIO ECONOMIC FACTORS				
Mother's Employment				
Not employed	rc	rc	rc	rc
Employed	1.42**	1.40**	1.31**	1.45**
Mothers Educational Status				
Has no education	rc	rc	rc	rc
Has primary education	0.58***	0.67***	0.66***	0.88***
Has secondary education	0.55**	0.67**	0.45**	0.66***
Economic status				
Wealth Quintiles third or higher				
Wealth Quintiles Second or Low	1.04	1.11	1.43	1.05
ENVIRONMENTAL FACTORS				
Unsafe water	0.66	0.76	0.99	0.98

Unsafe sanitation	0.75	1.21	0.75	0.91
Unsafe fuel	1.18**	1.21**	1.76*	1.54*
BIOLOGICAL FACTORS				
Mothers Age at birth of child				
< 20 years	rc	rc	rc	rc
20-34 years	078	0.66	0.79	0.71
35 or more	1.33*	1.23**	1.01*	1.87*
Birth order and presence of same sex siblings at birth				
Birth order 2 or 3 with no same sex siblings	rc	rc	rc	rc
Birth order 2 or 3 with same sex siblings	0.97	0.78	0.86	0.84
Birth order 4 or higher with no same sex siblings	1.05	1.08	1.00	1.76
Birth order 4 or higher with same sex siblings	1.89**	1.34**	1.23**	1.43**
Sex of the child				
Male	rc	rc	rc	rc
Female	1.97**	1.76**	1.02	1.21**
BEHAVIOURAL FACTORS				
No antenatal visits	rc	rc	rc	rc
Antenatal visits	0.67*	0.85**	0.93*	0.86**
Lack of knowledge of ORS	1.42**	1.33**	1.54**	1.44**
Never Breastfed	1.75*	1.71**	1.56	1.51**
Wald Chi square	142.11	144.0	142.8	143.4

* Significance at 5% level   ** Significance at 10% level   rc - reference category

being constructed and it is included in the model.

Model Specification

The Model of determinants of infant and child mortality is based on the following functional relationships of variables. The probability of dying (hj) for a child i in the age group j can be expressed as

$hij = f(zij\ bij, eij, sij)$

Where;

The *'z'* variable represents biological factors , *'b'* represents behavioural factors, *'e'* explains environmental factors and *'s'* shows the socio economic factors which determine mortality.

RESULTS AND DISCUSSION

The estimated results of the regression model are given in Table 4 and 5.Since some of the determinants of infant and child mortality are different, two different models are fitted with two dependent variables viz. infant mortality and child mortality. In this regression model, most of the variables are dummy in nature.

These models included a selection of biological, behavioural, socio economic and environmental factors. The results are not expressed as coefficient estimates, but in the form of derived hazard ratios, which are shown in the table together with an indication of their significance. The interpretations of the hazard ratio are as follows. In the case of dummy variables, the hazard ratio is the ratio of the mortality risk of an infant/child with given characteristics in respect to an infant without those characteristics. In the case of quantitative variables, the hazard ratio is calculated in respect to the baseline hazard function, which is considered as the reference category. The ratio of less than one indicates a reduced risk associated with that factor. The detailed

Variables	Representation in the Model
Infant Mortality	One dummy variable
Child Mortality	One dummy variable
Mother's employment	One dummy variable
Mothers educational status	Three dummy variables indicating the categories of no education, primary and secondary
Wealth quintiles	Quantitative variable based on wealth index
Access to water	One dummy variable
Sanitation	One dummy variable
Fuel	One dummy variable
Multiple birth	One dummy variable
Mothers age at birth of child	Quantitative variable(age in completed years)
Birth interval	Quantitative variable(interval in completed months)
Birth order	Quantitative variable according to birth order
Sex of child	One dummy variable(Male: Female)
No. of tetanus injections	One dummy variable(less than two injections; two or more injections)
Antenatal visits	Quantitative variable
Breastfeeding	One dummy variable

interpretations of the models are given in the following discussions.

Socio Economic Factors

The socio economic factors included in the model are mother's employment, education and economic status. The economic status of women is assessed based on the wealth index. All variables coming under this category are found significant except the wealth index in the model. The hazard ratio of infants according to mother's employment status does not differ much from one. At the same time the child mortality among working mothers is nearly 40% higher than non working mothers in all South Indian states. As expected, the hazard ratio of infants and children of educated mothers are less than one in all the south Indian states. This shows that if mother is educated, the mortality of their infants and children are low. The asset ownership index and environmental variables are not proved to be significant in all the models.

Biological Factors

Most of the biological factors have significant influence on infant and child mortality. The highest hazard ratio is found for infants from multiple births for all the states. The hazard ratio for infants born as multiple birth is nearly five times higher than that of a normal birth. The hazard ratio of higher birth order infants and children are also very high in the model. The higher birth order with same sex siblings shows a higher hazard than that of low birth order children. Mother's age at birth also proved to be

significant with expected sign and hazard. The sex of the child also proved to be significant determinants of child mortality. At the same time it is not significant for infant mortality. That explains the gender differences in the child survival. The hazard ratio of female children in Andhra Pradesh, Karnataka and Tamil Nadu is higher than that of Kerala. This shows the discrimination according to the sex of the child in South India. This is expected to be the outcome of emerging son preferences in these states.

Behavioural Factors

The behavioural factors included in the model are tetanus immunization, prenatal checkups and breastfeeding and knowledge of ORS. Tetanus immunization and prenatal checkups are proved to be important in the reduction of infant mortality in all south Indian states. The results reveal that the hazard ratio of infants born to mothers who received two or more tetanus vaccinations are less than one for all south Indian states. The antenatal visits also show significant influences on the reduction of mortality in all south Indian states. The hazard ratios of never breastfed also show significant effects on infant mortality. The statistics show that the never breastfed cases are very minimum and most of the researchers are of the opinion that this variable does not explain much change in the infant mortality.

CONCLUSION

Development progress in any country is now widely measured with reference to the Millennium Development Goals organized by the United Nations in the year 2000.Reduction in

IMR and CMR is one of the MDGs. In the present study, different indicators are identified as the determinants of IMR and CMR. Infant and child mortality are moderately high in south India, varying widely from state to state. The southern state of Kerala still considered as a model for other states in south India in terms of infant and child health related indicators.

The poor performance of Andhra Pradesh in terms of these indicators needs further attention. The infant and child mortality in Andhra Pradesh are 53.5 and 21.0 respectively during 2005-06. These figures are far higher than that of Kerala. Only one child out of 1000 live births dies in Kerala. In other south Indian states it varies from 5.3 in Tamil Nadu to 12.1 in Karnataka.

Biological, behavioural, environmental and socio economic factors are assessed in the study. All biological factors viz. birth interval, birth order, mother's age at birth and birth weight are found to be the major determinants of mortality. Average birth interval of south Indian states is between 30.3 months in Karnataka to 41.2 in Kerala. The birth weights of nearly 80% of babies in South India belong to the recommended weight of above 2.5 kg.

Children's vaccination coverage, maternal care and breast feeding are the major determinants coming under the behavioural factors, of which antenatal, post natal checkups and place of delivery are found to be the major cause of mortality of infants and young children. The targeted goal of 100% doctor assisted delivery is still a distant dream of most of the Indian states. Even though the Indian average is 50.2% in doctor assisted delivery, south Indian states are in a sound position. More than 80% deliveries in south India are under the supervision of a doctor. Kerala is approaching to the targeted goal of 100% doctor assisted delivery. At present 98.1% of deliveries in Kerala are doctor assisted. Breast feeding practices are also considered as a major determinant of infant and child mortality. The statistics on breast feeding practices in south shows a satisfactory picture. More than 95% of infants in south India are properly breastfed.

All major determinants of child survival are assessed in the regression model along with mother's economic roles. The employment status of women is proved to be a significant determinant of child mortality. Children of employed mothers are more vulnerable to mortality than non employed mothers. The derived hazard ratio shows that the mortality of children of employed mothers is nearly 40% higher than non employed mothers. The educational status of women also showed a significant impact on the survival of their infants and children. The mortality of children of educated mothers is lower than that of non educated mothers in all south Indian states. The wealth index used in the model as a representation of the economic status of women proved to be insignificant in the determinants of infant and child mortality.

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