FACTORS AFFECTING INFANT MORTALITY IN INDIA

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ABSTRACT

The purpose of this study is to investigate the factors affecting infant mortality in India as informed by the "Demographic Transition Theory." This theory suggests that improved standard of living, public health programs, changes in nutrition, technological and medical advances, and sanitary reforms promote a decline in the level of mortality. Using the data from the National Family Health Survey, India: 1998-1999, this study tests the following major hypothesis: *The higher the level of socioeconomic development, the lower the infant mortality rate among the states of India.* The findings support the demographic transition theory in large measure, revealing that the overall socioeconomic development is inversely related to infant mortality rate among the states of India.

INTRODUCTION

Infant mortality rate is often used as an important indicator of human development and general health conditions of any society. The chances that a newborn baby in many developing countries, such as India, would be alive on its first birthday are low despite an overall decline in mortality. Until 1920, infant mortality rates in India had fluctuated at a high level due to chronic food shortages, influenza and severe epidemics (small-pox, malaria and typhoid), and poor sanitary conditions. Since 1920, there has been a steady decline in infant mortality, followed by a rapid decline after the 1970s due to the government's efforts to extend health services to villages (Table 1). The government's universal national immunization program, which was accelerated in the mid-1980s, was meant to reduce mortality from six major preventable diseases (tuberculosis, diphtheria, pertussis, tetanus, polio, and measles) by providing free vaccinations for all children (Visaria & Visaria 1995 18). As a result, the infant mortality rate of India has declined from 89 in the 1980s to 66 per 1,000 live births in 2001 (India, Registrar General, Annual Issues).

Infant mortality rates reflect the socioeconomic development of societies with the most developed countries having the lowest infant mortality rates (Daugherty & Kammeyer 1995 145). North America and Europe have the lowest rates, 7 infant deaths per 1,000 live births. On the other hand, in all of Asia, the infant mortality rate is 54 infant deaths per 1,000 live births. In Latin American and Caribbean countries the rate is 29 infant deaths per 1,000 live births, and in the African countries the rate is 90 infant deaths per 1,000 live births (Population Reference Bureau 2004).

Table 1: Infant Mortality in India: 1900-2001

Period	Infant Mortality Rate
1900-1910	221
1911-1920	211
1921-1930	176
1931-1940	168
1941-1950	148
1951-1960	109
1961-1970	106
1971-1980	103
1981-1990	89
1991-2000	69
2001	66

Source: India, Registrar General, *India Vital Statistics*, Vital Statistics Division, Annual Issues, New Delhi.

Social researchers have studied the relationship between socioeconomic development and infant mortality many times at the cross-national and sub-national levels. Although the overall infant mortality rate has declined in India, it varies considerably among the states. Therefore, the purpose of this study is to examine the role of various socioeconomic factors influencing infant mortality in the states of India.

THEORETICAL FRAMEWORK AND HYPOTHESIS

The theoretical orientation of this research is based on one of the most empirically supported theories explaining contemporary dynamics of fertility and mortality. This theory attributes the economic development historically associated with industrialization to a variety of social changes primarily affecting women. Structural changes occurring during this process of modernization cause the high fertility and mortality rates typical of an agricultural society to be replaced by a de-

cline in mortality rates, followed by a subsequent decline in fertility rates, leading eventually to population stability in a given society. This theory has been called the "*Theory of Demographic Transition*" in the demography literature. Notestein (1945), Davis (1949), Stolnitz (1964) and Lee (2003) are some of the demographers who have employed this theory. According to the demographic transition theory, fertility and mortality declined, first in Europe during the nineteenth century and later elsewhere as other societies followed suit, was largely the result of economic development. Coale and Hoover (1958 9-10) elaborate on the consequences of economic development:

> Economic development has the effect of bringing about a reduction in death rates. Economic development involves evolution from a predominantly agrarian economy to an economy with a greater division of labor, using more elaborate tools and equipment, more urbanized, more oriented to the market sale of its products, and characterized by rapid and pervasive changes in technique. It also involves improvement in transportation, communications, and productivity, and these improvements had the effect of bringing a striking reduction in death rates. The reduction in death rates may be ascribed partly to greater regularity in food supplies, to the establishment of greater law and order, and to other fairly direct consequences of economic change. Other factors contributing to decline—improvements in sanitation, the development of vaccines and other means of preventive medicine, and great and rapid strides in the treatment of disease—can themselves be considered as somewhat indirect consequence of economic change.

With regard to mortality, the causal economic factors include more societal resources devoted to health research and development of a pest and waste management infrastructure. The social factors affecting a drop in mortality include dissemination and adoption of behaviors implied by health research and efficient use of the pest and waste management infrastructure. Societies undergoing this transition have typically experienced an initial drop in mortality, followed by a period characterized by rapid population growth. Possibly due to the negative connotations associated with death, there is typically a much more concerted initial effort by society to reduce mortality than fertility (Caldwell 1997; World Bank 1984).

A number of studies have sought to clarify the complex relationship between socioeconomic development and mortality in developed and developing countries. Economic development, characterized by increasing gross national product and per capita income, is a significant factor affecting mortality. Increased per capita income increases the potential tax base, allowing greater expenditures on the utilities infrastructure, which creates a general living environment that is freer of disease-causing microbes. Variables associated with this infrastructure, such as availability of water, electricity, and toilet facilities, are therefore associated either directly or indirectly with infant mortality (Defo 1994; United Nations 1991a).

Urbanization is another characteristic of socioeconomic development found to have a profound influence on infant mortality. Throughout the developing countries of the world, conditions of life in rural areas for infants and children are very often worse than they are in cities. In India, overall mortality and infant mortality in urban areas is lower than in rural areas. The results of the National Sample Survey in 2001 showed an infant mortality rate of 42 in urban areas and 72 in rural areas. The lower crude death rate and infant mortality rate in urban areas are attributable to better sanitary conditions, protected drinking water, and ready availability of medical facilities (India, Registrar General 2002).

Unclean cooking fuels, such as wood and dung, in households also affect infant and child mortality. If children spend a great deal of time where cooking fuel is emitting harmful smoke, it can increase their risk of respiratory disease and early mortality. The type of cooking fuel used may be an indicator of a household's socioeconomic status (Mishra & Retherford 1997).

Tetanus is one of the major causes of infant mortality in developing countries. It is highly recommended that pregnant women receive tetanus oxide vaccine in such countries (Stanfield & Galazka 1984). Another important development reducing infant mortality in developing countries is occurring with the dissemination of information on treatment of diarrheal diseases by families in the home. Diarreheal, infectious and respiratory

Table 2: Infant Mortality Rate (IMR) and Socioeconomic Development Variables of the States of India: 1998-1999

			(a) Modernization Variables: 1-7													
State	**IMR**		**1**		**2**		**3**		**4**		**5**		**6**		**7**	
Andhra Pradesh	65.8	**18**	24.9	**14**	64.3	**4**	58.7	**22**	78.5	**14**	27.3	**6**	74.4	**12**	76.3	**15**
Arunachal Pradesh	63.1	**16**	15.9	**6**	27.6	**13**	59.6	**23**	80.7	**15**	73.9	**20**	68.9	**10**	63.3	**9**
Assam	69.5	**19**	8.5	**1**	40.7	**11**	20.2	**3**	60.1	**5**	63.2	**18**	26.4	**2**	52.6	**5**
Bihar	72.9	**20**	10.2	**3**	71.0	**1**	26.4	**9**	75.4	**12**	16.8	**2**	18.2	**1**	27.3	**1**
Delhi	46.8	**9**	92.1	**25**	19.8	**19**	20.9	**5**	98.7	**24**	94.4	**24**	97.7	**25**	92.7	**25**
Goa	36.7	**3**	41.6	**22**	10.1	**24**	47.4	**14**	61.8	**6**	58.9	**17**	93.5	**22**	88.4	**23**
Gujarat	62.6	**15**	42.5	**23**	40.7	**10**	50.8	**17**	84.5	**17**	45.1	**11**	84.3	**19**	66.2	**11**
Haryana	56.8	**13**	28.8	**16**	41.5	**9**	12.6	**2**	88.0	**22**	39.1	**10**	89.1	**20**	66.9	**12**
Himachal Pradesh	34.4	**2**	9.1	**2**	10.7	**23**	20.8	**4**	77.4	**13**	27.0	**5**	97.2	**24**	83.7	**21**
Jammu & Kashmir	65.0	**17**	21.5	**10**	22.1	**18**	42.4	**12**	70.6	**11**	51.0	**14**	90.1	**21**	74.4	**14**
Karnataka	51.5	**12**	34.8	**20**	46.3	**7**	52.1	**18**	87.0	**21**	38.6	**9**	80.9	**16**	78.6	**17**
Kerala	16.3	**1**	23.1	**11**	17.0	**20**	25.0	**8**	19.9	**1**	85.2	**22**	71.8	**11**	88.5	**24**
Madhya Pradesh	86.1	**23**	25.3	**15**	64.7	**3**	57.2	**21**	63.5	**8**	22.2	**3**	68.1	**9**	54.8	**6**
Maharashtra	43.7	**7**	41.3	**21**	47.7	**6**	55.7	**20**	81.9	**16**	46.0	**13**	82.1	**17**	70.4	**13**
Manipur	37.0	**4**	33.7	**18**	9.9	**25**	69.9	**25**	48.9	**4**	92.0	**23**	75.3	**13**	83.8	**22**
Meghalaya	89.0	**25**	20.0	**7**	25.5	**14**	47.6	**15**	42.1	**3**	52.0	**16**	41.2	**6**	62.7	**8**
Mizoram	37.0	**5**	52.9	**24**	11.6	**22**	49.9	**16**	63.2	**7**	97.7	**25**	84.1	**18**	83.1	**20**
Nagaland	42.1	**6**	20.3	**9**	22.9	**16**	63.9	**24**	40.5	**2**	74.4	**21**	56.3	**7**	64.3	**10**
Orrissa	81.0	**22**	11.0	**4**	37.6	**12**	30.6	**11**	65.3	**9**	13.5	**1**	33.8	**3**	44.3	**3**
Punjab	57.1	**14**	30.8	**17**	11.6	**21**	9.4	**1**	98.9	**25**	51.4	**15**	95.5	**23**	82.0	**19**
Rajasthan	80.4	**21**	24.2	**13**	68.3	**2**	43.5	**13**	69.8	**10**	28.2	**7**	64.4	**8**	36.9	**2**
Sikkim	43.9	**8**	14.2	**5**	22.3	**17**	22.1	**6**	84.6	**18**	72.7	**19**	80.7	**15**	78.5	**16**
Tamil Nadu	48.2	**10**	34.6	**19**	24.9	**15**	53.8	**19**	85.0	**19**	34.1	**8**	78.8	**14**	79.7	**18**
Uttar Pradesh	86.7	**24**	20.0	**8**	62.4	**5**	23.4	**7**	85.6	**20**	26.7	**4**	36.6	**4**	45.3	**4**
West Bengal	48.7	**11**	23.8	**12**	45.9	**8**	28.5	**10**	89.3	**23**	45.1	**12**	36.7	**5**	61.4	**7**
Mean	56.9		28.2		34.7		39.7		72.0		51.1		69.0		68.2	
STD Deviation	19.1		17.6		20.0		17.6		19.1		25.0		23.8		17.2	

Source: International Institute for Population Sciences (IIPS), *National Family Health Survey,* India: *1998-1999,* Mumbai.

Note: The first column under a variable indicates the measured rate, the second column under a variable indicates the ranking of the respective values of infant mortality rate and socioeconomic development variables–modernization, health, education, and family planning.

Note: Independent Variables: 1 - Percent urban population; **2** - Percent women marriaed at 18 years and under; **3** - Percent women age 15-49 employed; **4** - Percent households with drinking water facility from pipe or pump; **5** - Percent households with sanitary toilets; **6** - Percent households with electricity; and **7** - Percent exposed to mass media.

diseases are largely due to contaminated food and water, as well as other unsanitary environmental conditions that create and foster the growth of various types of bacterial and viral agents. Therefore, simple and effective treatment of sick children and better medical care can sharply decrease infant mortality rates (Black 1984; Barbieri 1998). This information can only be effectively disseminated when a society's economic development facilitates an extensive media communication network.

Maturity of an infant at birth has been found to be an important factor affecting infant mortality. Rising infant mortality is closely associated with decreasing birth weight of birth cohorts and weight deficiencies of the newborn (Hansen 1996; Gomes & Santo 1997). Controlling for birth weight or maturity status of an infant also depends upon breast feed-

Table 2: Infant Mortality Rate (IMR) and Socioeconomic Development Variables of the States of India: 1998-1999, continued

	(b) Health Variables: 8-17															
State	**8**		**9**		**10**		**11**		**12**		**13**		**14**		**15**	
Andhra Pradesh	58.7	**15**	92.7	**22**	81.5	**19**	49.8	**18**	65.2	**20**	37.7	**12**	20.3	**9**	49.8	**11**
Arunachal Pradesh	20.5	**6**	61.6	**9**	45.6	**3**	31.2	**11**	31.9	**6**	24.3	**23**	21.0	**16**	62.5	**6**
Assam	17.0	**4**	60.1	**6**	51.7	**6**	17.6	**5**	21.4	**2**	36.0	**14**	20.1	**7**	69.7	**1**
Bihar	11.0	**1**	36.3	**2**	57.8	**10**	14.6	**2**	23.4	**4**	54.4	**3**	19.4	**2**	63.4	**2**
Delhi	69.8	**19**	83.5	**15**	84.9	**21**	59.1	**22**	65.9	**21**	34.7	**15**	23.7	**25**	40.5	**21**
Goa	82.6	**23**	99.0	**25**	86.1	**22**	90.8	**24**	90.8	**24**	28.6	**19**	21.6	**21**	36.4	**23**
Gujarat	53.0	**13**	86.4	**17**	72.7	**13**	46.3	**17**	53.5	**15**	45.1	**8**	20.7	**13**	46.3	**17**
Haryana	62.7	**18**	58.1	**5**	79.7	**18**	22.4	**8**	42.0	**12**	34.6	**16**	21.3	**20**	47.0	**16**
Himachal Pradesh	83.4	**24**	86.8	**18**	66.2	**12**	28.9	**10**	40.2	**11**	43.6	**10**	20.8	**14**	40.5	**20**
Jammu & Kashmir	56.7	**14**	83.2	**14**	77.7	**17**	35.6	**14**	42.4	**13**	34.5	**17**	21.0	**17**	58.7	**8**
Karnataka	60.0	**17**	86.3	**16**	74.9	**15**	51.1	**19**	59.1	**17**	43.9	**9**	20.4	**11**	42.4	**18**
Kerala	79.7	**22**	98.8	**24**	86.4	**23**	93.0	**25**	94.0	**25**	26.9	**22**	22.0	**22**	22.7	**25**
Madhya Pradesh	22.4	**8**	61.0	**8**	55.0	**9**	20.1	**6**	29.7	**5**	55.1	**1**	19.8	**4**	54.3	**10**
Maharashtra	78.4	**21**	90.4	**20**	74.9	**16**	52.6	**20**	59.4	**18**	49.6	**6**	20.2	**8**	48.5	**14**
Manipur	42.3	**9**	80.2	**13**	64.2	**11**	34.5	**13**	53.9	**16**	27.5	**21**	21.1	**19**	28.9	**24**
Meghalaya	14.3	**3**	53.6	**4**	30.8	**1**	17.3	**4**	20.6	**1**	37.9	**11**	20.3	**10**	63.3	**3**
Mizoram	59.6	**16**	91.8	**21**	37.8	**2**	57.7	**21**	67.5	**22**	27.7	**20**	20.4	**12**	48.0	**15**
Nagaland	14.1	**2**	60.4	**7**	50.9	**4**	12.1	**1**	32.8	**7**	24.1	**24**	20.9	**15**	38.4	**22**
Orrissa	43.7	**10**	79.5	**12**	74.3	**14**	22.6	**9**	33.4	**8**	54.4	**2**	19.2	**1**	63.0	**4**
Punjab	72.1	**20**	74.0	**11**	89.9	**24**	37.5	**15**	62.6	**19**	28.7	**18**	23.0	**24**	41.4	**19**
Rajasthan	17.3	**5**	47.5	**3**	52.1	**7**	21.5	**7**	35.8	**10**	50.6	**5**	19.9	**5**	48.5	**13**
Sikkim	47.4	**12**	69.9	**10**	52.7	**8**	31.5	**12**	35.1	**9**	20.6	**25**	22.0	**23**	61.1	**7**
Tamil Nadu	88.8	**25**	98.5	**23**	95.4	**25**	79.3	**23**	83.8	**23**	36.7	**13**	21.0	**18**	56.5	**9**
Uttar Pradesh	21.2	**7**	34.6	**1**	51.4	**5**	15.5	**3**	22.4	**3**	51.7	**4**	20.0	**6**	48.7	**12**
West Bengal	43.8	**11**	90.0	**19**	82.4	**20**	40.1	**16**	44.2	**14**	48.7	**7**	19.7	**3**	62.7	**5**
Mean	48.8		74.6		67.1		39.3		48.4		38.3		20.8		49.7	
STD Deviation	25.5		19.1		17.5		23.0		21.4		10.8		1.1		11.8	

Note: (b) Health Variables: **8** - Percent children immunized; **9** - Percent mothers receiving antenatal care; **10** - Percent mothers receiving tetanus toxoid vaccine; **11** - Percent births delivered in health facility; **12** - Percent deliveries assisted by health professionals; **13** - Percent underweight children under 3 years; **14** - Women's mean body mass index; **15** - Percent of women with any anaemia; **16** - Percent of households using adequately iodized salt; and **17** - Percent of women consuming milk or curd.

ing patterns and maternal age of the mother. The results indicate that the infant mortality rates are inversely related to mothers who breastfeed children and maternal age (Cabigon 1997; Nath, Land, & Singh 1994).

Higher incidence of infant mortality in developing countries can be partly attributed to behaviors of the mother prior to and during pregnancy known to cause premature birth. These include poor nutritional practices, short intervals between pregnancies, tobacco smoking, alcohol or substance abuse, and inadequate prenatal care. Inadequate prenatal care also greatly reduces the chances of survival of an infant born prematurely. The decline in infant mortality is attributed to the introduction of improved public health measures and access to maternal and child health services (Kabir, Chowdhury, & Amin 1995).

Some researchers have stressed education of women and maternal education as the key factor in the decline of infant mortality in developing countries. As the education level of a society increases, infant mortality rate goes down. Educational attainment of parents, especially that of mothers, has been found to have a significant negative relation-

Table 2: Infant Mortality Rate (IMR) and Socioeconomic Development Variables of the States of India: 1998-1999, continued

	(c) Education Variables: 18-22													
State	**16**		**17**		**18**		**19**		**20**		**21**		**22**	
Andhra Pradesh	27.4	**2**	72.0	**16**	36.2	**6**	67.7	**2**	70.5	**4**	4.9	**8**	4.0	**4**
Arunachal Pradesh	84.1	**21**	19.9	**2**	47.3	**11**	80.1	**14**	77.3	**10**	4.4	**3**	4.1	**5**
Assam	79.6	**20**	41.7	**8**	46.1	**10**	72.1	**9**	75.0	**7**	4.7	**4**	4.2	**6**
Bihar	46.9	**8**	46.7	**10**	23.4	**1**	59.6	**1**	54.1	**1**	3.6	**2**	2.7	**1**
Delhi	89.2	**23**	73.3	**19**	70.9	**22**	86.7	**22**	90.8	**21**	9.3	**25**	28.7	**25**
Goa	41.9	**5**	65.0	**13**	71.4	**23**	88.1	**23**	93.2	**23**	8.3	**24**	16.3	**24**
Gujarat	56.1	**11**	80.0	**21**	49.7	**12**	69.1	**3**	72.8	**6**	6.3	**16**	11.0	**20**
Haryana	71.0	**17**	93.2	**25**	44.8	**8**	82.2	**16**	85.5	**15**	6.2	**15**	9.2	**19**
Himachal Pradesh	90.5	**24**	87.0	**23**	63.7	**21**	94.3	**25**	97.3	**24**	7.5	**21**	7.6	**15**
Jammu & Kashmir	52.9	**10**	72.1	**17**	30.2	**4**	77.8	**11**	77.5	**11**	5.7	**13**	5.4	**10**
Karnataka	43.4	**6**	75.5	**20**	44.8	**9**	71.4	**8**	77.6	**12**	6.0	**14**	8.5	**18**
Kerala	39.3	**4**	45.3	**9**	87.4	**24**	90.9	**24**	97.4	**25**	8.1	**23**	15.6	**23**
Madhya Pradesh	56.7	**12**	32.5	**7**	31.5	**5**	69.6	**5**	70.8	**5**	4.8	**7**	5.9	**13**
Maharashtra	60.1	**13**	47.3	**11**	55.4	**16**	81.8	**15**	86.9	**16**	7.1	**20**	7.9	**17**
Manipur	87.9	**22**	15.3	**1**	57.1	**17**	86.6	**21**	87.8	**17**	8.0	**22**	14.5	**22**
Meghalaya	63.0	**15**	23.7	**5**	61.9	**20**	79.2	**12**	85.2	**14**	3.2	**1**	4.6	**7**
Mizoram	91.3	**25**	22.9	**4**	90.0	**25**	85.4	**20**	90.8	**22**	6.4	**17**	5.8	**12**
Nagaland	67.2	**16**	82.7	**22**	60.2	**18**	82.2	**17**	83.5	**13**	5.4	**12**	4.7	**8**
Orrissa	35.0	**3**	20.7	**3**	40.5	**7**	72.1	**10**	75.1	**8**	5.1	**11**	3.1	**2**
Punjab	75.3	**18**	91.1	**24**	61.2	**19**	84.9	**19**	90.0	**20**	6.4	**18**	12.7	**21**
Rajasthan	46.3	**7**	70.7	**15**	24.6	**2**	69.1	**4**	63.2	**2**	5.0	**9**	3.5	**3**
Sikkim	79.1	**19**	72.4	**18**	50.6	**14**	82.9	**18**	88.5	**18**	4.7	**5**	5.2	**9**
Tamil Nadu	21.2	**1**	66.5	**14**	52.5	**15**	79.7	**13**	88.5	**19**	6.4	**19**	7.6	**16**
Uttar Pradesh	48.8	**9**	57.2	**12**	29.8	**3**	69.9	**6**	69.4	**3**	5.0	**10**	6.9	**14**
West Bengal	61.7	**14**	25.0	**6**	50.0	**13**	70.9	**7**	76.7	**9**	4.7	**6**	5.5	**11**
Mean	60.6		56.0		51.2		78.2		81.0		5.9		8.2	
STD Deviation	20.5		25.1		17.5		8.6		11.0		1.5		5.8	

Note: (c) Education variables: **18** - Percent female literate; **19** - Percent household population age 6-14 years attending school; **20** - Percent females age 6-14 attending school; **21** - Median school years attained; and **22** - Percent women age 15-49 completing high school education and above.

ship with levels of childcare and infant mortality. Literate mothers usually give birth to healthier babies because they have more information about health-care facilities than illiterate mothers. They also have more influence within the family in deciding to take sick children for treatment (Mellington & Cameron 1999; Pitt 1995; Rajna, Mishra, & Krishnamoorthy 1998; United Nations 1991a). According to Caldwell (1997), mass education, which tends to emphasize modernization and secular attitudes, is the only means to enhance child survival and reduce mortality as well as fertility.

Promoting effective family planning programs and the wide availability of contraceptives also affect infant mortality, because they tend to lower the number of births to younger and older women and reduce the incidence of closely spaced births (Asari 1991; Gulati 1998). Voluntary adoption of family planning strategies is inhibited by perceptions that a large number of births are required for the survival of the family, which is common in agrarian economies with high infant mortality rates. Traditional social norms and customs that promote early marriage and frequent childbearing are seen as possible societal responses to perceptions of high infant mortality (Prasad 1997). Furthermore, the desire for sons as a source of labor and social security for parents in old age is one of the major features of Indian society. Differential mortality rates between male and fe-

Table 2: Infant Mortality Rate (IMR) and Socioeconomic Development Variables of the States of India: 1998-1999, continued

	(d) Family Planning Variables: 23-28											
State	**23**		**24**		**25**		**26**		**27**		**28**	
Andhra Pradesh	15.1	**4**	19.8	**5**	59.6	**18**	52.7	**25**	21.4	**18**	2.3	**19**
Arunachal Pradesh	18.7	**15**	41.9	**21**	35.4	**5**	20.6	**7**	22.6	**14**	2.5	**14**
Assam	18.1	**12**	38.2	**20**	43.3	**8**	15.7	**5**	21.8	**16**	2.3	**17**
Bihar	14.9	**2**	47.9	**24**	24.5	**2**	19.2	**6**	28.1	**5**	3.5	**5**
Delhi	19.0	**17**	23.1	**9**	63.8	**22**	26.3	**9**	21.3	**19**	2.4	**16**
Goa	23.2	**25**	17.0	**4**	47.5	**11**	27.8	**10**	16.6	**25**	1.8	**25**
Gujarat	17.6	**11**	33.2	**15**	59.0	**17**	43.0	**18**	24.3	**10**	2.7	**11**
Haryana	16.9	**9**	37.5	**17**	62.4	**20**	38.7	**17**	23.1	**12**	2.9	**9**
Himachal Pradesh	18.6	**14**	25.9	**10**	67.7	**25**	45.1	**19**	19.9	**22**	2.1	**22**
Jammu & Kashmir	18.2	**13**	38.0	**19**	49.1	**12**	28.0	**11**	23.1	**11**	2.7	**12**
Karnataka	16.8	**7**	13.0	**2**	58.3	**16**	51.5	**24**	20.4	**21**	2.1	**23**
Kerala	20.2	**22**	14.6	**3**	63.7	**21**	48.5	**22**	18.8	**24**	2.0	**24**
Madhya Pradesh	14.7	**1**	42.5	**22**	44.3	**9**	35.7	**16**	26.7	**6**	3.3	**6**
Maharashtra	16.4	**6**	27.1	**12**	60.9	**19**	48.5	**23**	23.0	**13**	2.5	**13**
Manipur	21.7	**23**	36.5	**16**	38.7	**6**	14.4	**3**	25.8	**7**	3.0	**7**
Meghalaya	19.1	**18**	20.9	**7**	20.2	**1**	6.5	**1**	35.7	**1**	4.6	**1**
Mizoram	22.0	**24**	26.0	**11**	57.7	**15**	45.2	**20**	25.7	**8**	2.9	**8**
Nagaland	20.1	**21**	32.7	**14**	30.3	**4**	12.3	**2**	30.4	**3**	3.8	**4**
Orrissa	17.5	**10**	37.6	**18**	46.8	**10**	33.9	**15**	22.1	**15**	2.5	**15**
Punjab	20.0	**20**	29.1	**13**	66.7	**24**	29.3	**12**	19.1	**23**	2.2	**20**
Rajasthan	15.1	**5**	47.5	**23**	40.3	**7**	30.8	**13**	29.9	**4**	3.8	**3**
Sikkim	19.8	**19**	22.4	**8**	53.8	**14**	22.4	**8**	24.5	**9**	2.8	**10**
Tamil Nadu	18.7	**16**	9.6	**1**	52.1	**13**	45.2	**21**	21.4	**17**	2.2	**21**
Uttar Pradesh	15.0	**3**	53.3	**25**	28.1	**3**	14.9	**4**	31.1	**2**	4.0	**2**
West Bengal	16.8	**8**	20.7	**6**	66.6	**23**	32.0	**14**	20.8	**20**	2.3	**18**
Mean	18.2		30.2		49.6		31.5		23.9		2.8	
STD Deviation	2.3		11.7		14.1		13.6		4.4		0.7	

Note: (d) Family Planning Variables: **23** - Median age at first marriage; **24** - Percent of women who want more sons than daughters; **25** - Percent using contraceptives; **26** - Percent sterilized; **27** - Crude birth rate; and **28** - Total fertility rate.

male babies is one of the many factors related to infant mortality risks in developing countries, with females having higher infant mortality rate than males (Athreya & Chunkath 1998).

The preceding discussion forms the central orientation of this study. The underlying assumption behind the theory of demographic transition, as shown through these various studies, is that as the level of development in a country increases, infant mortality level decreases. Thus, this study will test the following major hypothesis: *The higher the level of socioeconomic development, the lower the infant mortality rate will be among the states of India.*

DATA AND MEASUREMENT

Data for the study have been obtained from the second National Family Health Survey (NFHS-2) initiated by the Ministry of Health and Family Welfare, Government of India and funded by the United States Agency for International Development. The success of the first NFHS in 1992-93 in creating an important demographic and health database in India paved the way for repeating the survey. The International Institute for Population Sciences, Mumbai (IIPS), was designated as the modal agency for providing coordination and technical guidance to the NFHS. Interviews were conducted with a nationally representative sample of 89,119 ever-married women in the age group 15-49 from the 25

Table 3: Pearson Correlation Coefficients Between Socioeconomic Development Variables and Infant Mortality Rate in India

Socioeconomic Development Variables	Infant Mortality Rate
(a) Modernization	
1. Percent urban population	-0.314
2. Percent women married at age 18	0.657**
3. Percent women employed	-0.015
4. Percent households with drinking water facility	0.168
5. Percent households with sanitary toilets	-0.608**
6. Percent households with electricity	-0.539**
7. Percent exposed to mass media	-0.760**
(b) Health	
8. Percent children immunized	-0.670**
9. Percent mothers receiving antenatal care	-0.683**
10. Percent mothers receiving tetanus toxoid vaccine	-0.396
11. Percent birth delivered in health facility	-0.660**
12. Percent deliveries assisted by health professionals	-0.699**
13. Percent underweight children under 3 years	0.587**
14. Women's mean body mass index	-0.522**
15. Percent of women with any anaemia	0.640**
16. Percent household using adequately iodized salt	-0.249
17. Percent of women consuming milk or curd	-0.167
(c) Education	
18. Percent literate females	-0.748**
19. Percent household population age 6-14 attending school	-0.737**
20. Percent female age 6-14 attending school	-0.751**
21. Median school year attained	-0.723**
22. Percent women completing HS education and above	-0.483*
(d) Family Planning	
23. Median age at first marriage	-0.654**
24. Percent of women who want more sons than daughters	0.607**
25. Percent using contraceptives	-0.559**
26. Percent sterilized	-0.359
27. Crude birth rate	0.566**
28. Total fertility rate	0.588**

*Indicates a correlation which is significant at 0.05 level, two-tailed test.
**Indicates a correlation which is significant at 0.01 level, two-tailed test.

states of India. The main objective of the NFHS was to collect reliable and up-to-date information on mortality and morbidity, maternal and reproductive health, fertility and family planning. Data collection was carried out in two phases from November 1998 to March 1999. The two NFHS studies are the most comprehensive surveys of its kind ever conducted in India (IIPS 2000).

The two main concepts used in this research are 1) socioeconomic development (measure of the independent variable), and 2) infant mortality (measure of the dependent variable). The term "*socioeconomic development*" implies an ongoing process of change in a society and includes many indicators to describe the overall development of a society (Bongaarts 1978). However, in this study the following 28 variables are selected from the NFHS-2 data of the states of India, which are grouped into four major categories:

(a) *Modernization variables:* 1) the percent of the urban population; 2) the percent of women married at age 18 years and under; 3) the percent of women employed; 4) the percent of households with drinking water piped or from hand pump; 5) the percent of households with sanitary toilets; 6) the percent of households with electricity; and

Table 4: Infant Mortality Ranking and Composite Measures of Socioeconomic Development of India, by Major Categories

State	Infant Mortality	Modernization		Health		Education		Family Planning	
Andhra Pradesh	**18**	87	**9**	144	**13**	24	**3**	89	**17**
Arunachal Pradesh	**16**	96	**13**	103	**8**	43	**8**	76	**9**
Assam	**19**	45	**3**	73	**6**	36	**5**	78	**10**
Bihar	**20**	29	**1**	44	**1**	6	**1**	44	**3**
Delhi	**9**	147	**25**	201	**24**	115	**23**	92	**20**
Goa	**3**	128	**22**	199	**23**	117	**24**	100	**22**
Gujarat	**15**	108	**18**	145	**14**	57	**12**	82	**12**
Haryana	**13**	91	**11**	155	**18**	73	**16**	84	**14**
Himachal Pradesh	**2**	92	**12**	166	**20**	106	**22**	112	**23**
Jammu/Kashmire	**17**	100	**16**	141	**11**	49	**10**	78	**11**
Karnataka	**12**	108	**19**	148	**16**	61	**13**	93	**21**
Kerala	**1**	97	**15**	201	**25**	119	**25**	116	**25**
Madhya Pradesh	**23**	65	**6**	70	**5**	35	**4**	60	**6**
Maharashtra	**7**	106	**17**	147	**15**	84	**18**	86	**15**
Manipur	**4**	130	**23**	149	**17**	99	**21**	62	**7**
Meghalaya	**25**	69	**7**	57	**2**	54	**11**	29	**1**
Mizoram	**5**	132	**24**	158	**19**	96	**19**	86	**16**
Nagaland	**6**	89	**10**	120	**10**	68	**15**	48	**4**
Orrissa	**22**	43	**2**	66	**4**	38	**7**	83	**13**
Punjab	**14**	121	**21**	192	**22**	97	**20**	112	**24**
Rajasthan	**21**	55	**5**	77	**7**	20	**2**	55	**5**
Sikkim	**8**	96	**14**	143	**12**	64	**14**	68	**8**
Tamil Nadu	**10**	112	**20**	174	**21**	82	**17**	89	**18**
Uttar Pradesh	**24**	52	**4**	62	**3**	36	**6**	39	**2**
West Bengal	**11**	77	**8**	155	**9**	46	**9**	89	**19**

Note: The composite measures of each category, including modernization, health, education, and family planning is obtained by summing the ranks of values of each variable as shown in Table 2.

7) the percent of women 15-49 exposed to mass media.

(b) *Health variables:* 8) the percent of children immunized; 9) the percent of mothers receiving antenatal care; 10) the percent of mothers receiving tetanus toxoid vaccine; 11) the percent of births delivered in a health facility; 12) the percent of deliveries assisted by health professionals; 13) the percent of underweight children under 3 years; 14) women's mean body mass index; 15) percent of women with any anaemia; 16) percent of households using adequately iodized salt; and 17) percent of women consuming milk or curd.

(c) *Education variables:* 18) the percent of literate females; 19) the percent of the household population age 6-14 years attending school; 20) the percent of females age 6-14 years attending school; 21) the median school years attained; and 22) the percent of women age 15-49 years completing high school education and above.

(d) *Family planning variables*: 23) median age at first marriage; 24) percent of women who want more sons than daughters; 25) the percent using contraceptives; 26) the percent sterilized; 27) crude birth rate; and 28) total fertility rate.

The term "*infant mortality*" refers to death during the first year of life. The *infant mortality rate* is the number of deaths to infants under 1 year of age per 1,000 live births. Table 2 shows the infant mortality rate (IMR) and socioeconomic development variables of the states of India, based on NFHS-2 data from 1998-1999.

ANALYSIS OF DATA AND RESULTS

The analysis of data and results presented below are based on three commonly used statistical procedures appropriate for

the respective levels of measurement for the variables used. 1) Pearson's correlation coefficient measures the association between interval level variables. 2) Spearman's correlation coefficient measures the association between the composite ordinal level variables, and 3) multiple regression analysis models the interval infant mortality variable using the predictor variables of socioeconomic development.

Pearson's Correlation Coefficient

Table 3 presents Pearson's correlation coefficients between socioeconomic development variables and infant mortality rate in India. An examination of the data shows that of the total 28 socioeconomic development variables, 27 are related to infant mortality rate in the direction predicted by demographic transition theory. Of these, 2 are statistically significant at the 0.05 level, while 20 are significant at the 0.01 level. These statistics strongly confirm the research hypothesis. The results of the major categories of socioeconomic development and infant mortality rate are as follows:

(a) *Modernization*: Among the seven modernization variables, all but one are correlated in the predicted direction with infant mortality rate. Of the 6 variables correlated, four are statistically significant at the 0.01 alpha level, including percent women married at age 18 (0.657), percent of households with sanitary toilets (-0.608), percent households with electricity (-0.539), and percent exposed to mass media (-0.760).

(b) *Health*: Among the ten health variables, all are correlated in the predicted direction with infant mortality rate. Of these, seven variables are correlated at the 0.01 alpha level, including percent children immunized (-0.670), percent mothers receiving antenatal care (-0.683), percent birth delivered in health facility (-0.660), percent of deliveries assisted by health professionals (-0.699), percent of underweight children under 3 years (0.587), women's mean body mass index (-0.522), percent of women with any anaemia (0.640), while another variable percent mothers receiving tetanus toxoid vaccine (-0.396), is significant at the 0.05 alpha level.

(c) *Education*: Among the five education variables, all are correlated in the predicted direction with infant mortality rate. Of these, four are statistically significant at the 0.01 alpha level, including percent of literate females (-0.748), percent of the household population age 6-14 years attending school (-0.737), percent of females age 6-14 years attending school (-0.751), and median school years attained (-0.723). The variable the percent of women completing high school education (-0.483) and above is statistically significant at the 0.05 level.

Table 5: Spearman's Correlation Coefficients Between the Composite Measures and Infant Mortality Rate in India

Socioeconomic Development	Infant Mortality Rate
1. Modernization	-0.686**
2. Health	-0.802**
3. Education	-0.848**
4. Family Planning	-0.599**

**Indicates a correlation coefficient which is significant at 0.01 level, two-tailed test.

(d) *Family Planning*: Among the six family planning variables, all are correlated in the predicted direction with infant mortality rate. The variables median age at first marriage (-0.654), percent of women who want more sons than daughters (0.607), percent using contraceptives (-0.559), crude birth rate (0.566) and total fertility rate (0.588) is statistically significant at the 0.01 alpha level.

Spearman's Correlation Coefficient

In this study an attempt is made to formulate a composite measure of each category of socioeconomic development, including modernization, health, education, and family planning. Although the variables comprising the composite measures are varied, they represent equally weighted aspects of the broad constructs of the level of development used by demographers (Population Crisis Committee 1988; United Nations 1991b).

The composite measure for each category of socioeconomic development is calculated by ranking all the states of India with respect to socioeconomic development variables—that is, ranked within each variable with the highest development value receiving a rank of 25 and the lowest development value receiving a rank of 1. Thus, each state has a rank for each variable as shown in Table 2. The composite measure for each category is obtained by summing the ranks of values of each variable in that category as shown in Table 4. Furthermore, the states are ranked for each composite measure of socioeconomic development. Similarly, all the states

Table 6: Multiple Regression Analysis Using Socioeconomic Development Variables To Explain Infant Mortality in India

Socioeconomic Development Variables	Infant Mortality Rate		
	Beta	t	Sig.
1. Percent Underweight Children Under 3	0.294	2.079	0.051
2. Percent Females Literate	-0.281	-1.650	0.115
3. Median School Year Attained	-0.329	-2.071	0.052
4. Percent Using Contraceptives	-0.233	-1.700	0.105

Constant = 92.564; R Square = 0.751; F Ratio = 15.059***; N = 25

***Significance < .001

of India are ranked according to their respective infant mortality rate, that is, the lowest infant mortality rate receiving a rank of 1 and the highest rate receiving a rank of 25, as shown in Table 2.

Table 5 presents Spearman's correlation coefficients for the composite measures of socioeconomic development and infant mortality rate. An examination of the data shows that all four major categories of socioeconomic development have negative association with infant mortality rate as predicted by the demographic transition theory. All composite measures are statistically significant at the 0.01 alpha level, including modernization (-0.686), health (-0.802), education (-0.848), and family planning (-0.599).

Multiple Regression Analysis

Finally, in an effort to model infant mortality rate using the variables of socioeconomic development, an OLS (ordinary least squares) multiple regression analysis is carried out. The model was developed by screening the correlation matrix of independent variables to exclude those with high covariance. Low Beta coefficients were systematically eliminated, resulting in the final model presented in Table 6. The table includes: a) standardized regression coefficients (Beta); b) the values of t statistics corresponding to each coefficient estimate; c) the value of t significance; d) the value of the R square, the overall fitness of the model, and e) the value of F statistics.

The model uses four measures of socioeconomic development: 1) percent underweight children under 3 years; 2) percent of females literate; 3) median school year attained; and 4) percent using contraceptives, to explain 75.1 percent of the variance in infant mortality rate. This model exhibits a high F ratio statistic (15.059) that is significant at the 0.001 alpha level. The highest Beta values and t significances are for percent underweight children under 3 years (sig.= 0.051) and median school years attained (sig. = 0.052), indicating that these variables explain most of the variance in infant mortality rate. These data suggest that malnutrition among babies under 1 year and lack of basic education among parents are the major causes of the high infant mortality rate in India. Although percent of females literate (sig. = 0.115) and percent using contraceptives (sig.= 0.105) are not significant at the 0.05 alpha level, the relatively high Beta values suggest that high levels of literacy among females and widespread use of contraceptives have a substantial inverse impact on infant mortality and explain much of its variation among the states of India. Although the lack of statistical significance among the independent variables can be largely explained by the small sample size (n=25), statistical significance is not a crucial methodological concern, since the 25 cases comprise the entire population under study.

CONCLUSION

Although the states of India differ widely in socioeconomic characteristics and infant mortality rates, the findings of this study support the demographic transition theory in large measure, revealing that 27 of the 28 socioeconomic development variables are correlated in the expected direction with infant mortality rate, of which 2 are statistically significant at the 0.05 alpha level and 20 significant at the 0.01 alpha level. The study concludes that the overall level of modernization, health care, and education, accompanied by effective access to family planning information and services, play a significant role in lowering infant mortality. Finally, the study suggests that higher levels of education among parents, together with proper nutrition for infants, will lead to a decline in

infant mortality.

The theme "Population and Development," adopted by the third once-in-a-decade International World Population Conference held in Cairo, Egypt in 1994 (United Nations 1995) represents a significant change in thinking about population, shifting in emphasis from family planning to economic development. The results of this study suggest that this shift in emphasis has had a positive effect on infant mortality.

The results presented here have several important policy implications for reducing infant mortality. Governmental policies aimed at intensifying child immunization programs, improving educational levels, especially of women, creating basic awareness about health problems through mass media, providing effective child health care services, promoting sanitary reforms and access to clean water, especially in urban areas, introducing nutritional programs for children, developing prenatal care and obstetric programs, increasing hospitalization for deliveries, and providing effective family planning services should have a significant impact on infant mortality.

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