Infant and Under-Five Mortality in India:

Levels, Patterns, and Correlates

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A high rate of infant and under-five mortality is one of the worst health problems afflicting India. Approximately 1¾ million children die each year before reaching their first birthday, and another ¾ million die before the age of 5, representing one of the greatest wastes of human potential in the country. India has signed on to the Millennium Development Goals, which call for a reduction of infant and under-five mortality rate by two-thirds from 1990 to 2015. This would imply a goal of 27 infant and 32 under-five deaths per 1,000 live births by 2015. The Tenth Five-Year Plan is even more ambitious, with its call for a reduction of infant mortality to 45 deaths per 1,000 live births by 2007.

There have been relatively few recent studies of the patterns and correlates of infant mortality in India, especially using unit record data. Hughes and Dunleavy (2000) used data from the first National Family and Health Survey (NFHS) (conducted in 1992-93) to focus on the association between household environmental variables, especially the use of clean cooking fuels (such as kerosene or bottled natural gas as opposed to cow dung or wood), and infant mortality. Bhargava (2003) also used the first NFHS data, but only for Uttar Pradesh, to analyze the association between the presence of older boys and girls in a household and the mortality risk of

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children in that household. James *et al.* (2000) analyze data from the second NFHS (conducted in 1998-99), but only for the state of Andhra Pradesh, to investigate the proximate causes of neonatal mortality and find the previous birth interval, a child's first-born status, and mother's schooling as significant risk factors. Arulampalam and Bhalotra (2004) also use data from the second NFHS (conducted in 1998-99) to study the causal process at work within families whereby the death of a child elevates the risk of death of the succeeding sibling. They find large "scarring" effects for 14 of the 15 large Indian states. Finally, using the second NFHS data, Bhalotra and van Soest (2005) estimate a dynamic panel data model of neonatal mortality and birth spacing to understand the causal effects of birth spacing on subsequent mortality and of mortality on the next birth interval, while controlling for unobserved heterogeneity in mortality and birth spacing. They find a clear effect of birth spacing on mortality but find that it can explain only a limited share of the correlation between neonatal mortality of successive children in a family.

A. Overall Trends

Infant mortality has declined impressively in India – from 130-140 infant deaths per 1,000 live births in the early 1970s to 68 in 2000, representing an annual rate of decline of about 2.6 percent (Figure 1). Further, there is no evidence of a slow-down in the rate of infant mortality decline over this period.[2]

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[2] A regression of the log of the infant mortality rate from 1971 to 2000 on the time trend and the square of the time trend results in a coefficient on the squared term that is not significantly different from zero. However, the rate of infant mortality decline during the 1990s was slower

The data in Figure 1 also suggest that the rural areas of the country have seen a slightly greater decline in infant mortality than the urban areas, although the rural-urban gap in infant mortality remains very wide (with the rural infant mortality rate being 72% greater than the corresponding urban rate).

While India has managed to reduce its infant mortality rate significantly over the last three decades, its performance on infant mortality reduction pales in comparison to that of many other countries in South, Southeast and East Asia. Infant mortality has fallen by anywhere from 3-5% annually in the countries shown in Figure 2, with South Korea being the stellar performer. Even within South Asia, Sri Lanka and Bangladesh have managed to reduce their infant mortality at a faster rate than India (4.3% and 3.3%, respectively). Indeed, what is surprising is that the *level* of infant mortality is now higher in India than in Bangladesh – a country whose per capita GDP is only about one-half that of India.

Data from the National Family Health Surveys indicate that the under-five child mortality rate was 109 deaths per 1,000 live births in 1992-93 and declined to 95 deaths per 1,000 live births by 1998-99, an almost identical rate of decline to that in the infant mortality rate. The patterns of inter-state and inter-regional disparities in the under-five mortality are very similar to those observed for infant mortality. This is not surprising as infant deaths constitute more than 70% of all under-five child deaths in the country.

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than during the 1980s, as Cleason *et al.* (1999, 2000) have argued (although it was not slower than during the 1970s).

B. Inter-State Variations

It is almost meaningless to talk about an *average* infant mortality rate for India, as there are extremely wide inter-state variations within the country. The infant mortality rate in India ranges from a low of 14 deaths per 1,000 live births in Kerala to a high of 96 deaths per 1,000 live births in Orissa (Figure 3). Thus, Kerala is comparable to Bulgaria, Russia and Ukraine in terms of its infant mortality rate, while Orissa is comparable to Lesotho, Cameroon and Tanzania. This is a wide range of infant mortality rates for a single country.

How have different Indian states performed in terms of reducing their infant mortality rates? The data shown in Figure 3 are intriguing, since they go against many widely-held perceptions. For instance, the state with the lowest level of infant mortality in 1981 – Kerala – reduced its infant mortality at the fastest rate (5% annually) between 1981 and 2000. But Bihar and Uttar Pradesh, which had among the highest infant mortality in the country in 1981, were also among the top performers in infant mortality reduction over the same period. Andhra Pradesh and Karnataka – states that are normally perceived to be good human development performers – had the slowest rate of infant mortality decline over the two decades. In general, there was some – although limited – convergence in infant mortality, so that inter-state disparity in infant mortality decreased between 1981 and 2000.[3]

[3] For instance, the log variance of the infant mortality rate across states fell from 4.7 in 1971 to 4.1 in 2000.

C. Intra-State Variations

The state averages of infant mortality mask substantial intra-state variation. Unfortunately, recent estimates of infant mortality are not available at the district level. But estimates are available at the regional level for 1997-99 from the Sample Registration Surveys (SRS).[4] Figure 4, which shows region-level estimates of infant mortality for the country, indicates that the regional infant mortality rate ranges from a low of 7.8 deaths per 1,000 live births to a high of 125.3 deaths per 1,000 live births. The infant mortality rate in Northern Kerala is more than two times as high as that in Southern Kerala (19 versus 7.8 deaths per 1,000 live births). In Karnataka, the infant mortality rate ranges from 38.8 in the Coastal & Ghats region to 76.5 in the Inland Southern region. The map suggests that the interior of the country generally has higher infant mortality than the coastal regions, with a few exceptions.

Figure 5 shows a map of the relative changes in infant mortality between 1988-92 and 1994-98 across regions, based on data from the NFHS-1 and NFHS-2. What the map suggests is that, while infant mortality fell in most parts of the country, a number of regions experienced no change or even an increase in infant mortality. These regions are not located in particular parts of the country but can be found in the West, Center and the South.

[4] Regions are a collection of several districts grouped together on the basis of broadly-similar agro-climatic conditions. They are not, however, administrative units. The National Sample Surveys (NSS) have defined a total of 78 regions for India.

D. Geographic Concentration of Infant Deaths

If India's goal is to achieve the largest reduction possible in the *absolute* number of infant deaths in the country, it is useful to look at the cumulative distribution of infant deaths by state. Figure 6, which plots the individual as well as the cumulative contribution of 21 large states to the total number of infant deaths in the country in 2000, shows that Uttar Pradesh alone contributes one-quarter of all infant deaths in the country.[5] Four states – Uttar Pradesh, Madhya Pradesh, Bihar and Rajasthan – together account for slightly more than one-half of all infant deaths in India. The geographical concentration of infant deaths points to the importance as well as the potential efficacy of state-level targeting of infant mortality-reducing interventions.

In principle, targeting interventions to a smaller geographical unit, such as a district or village, could be even more effective.[6] The NFHS-2 data are suggestive of infant deaths in India being heavily concentrated in a relatively small number of districts and villages. For instance, in the period 1994-99, a mere 20% of the villages and 22.5% of the districts in the NFHS-2 sample with the largest number of infant deaths accounted for half of all infant deaths in the country (Figure 7). Since the NFHS-2 covered only a fraction of all the villages in the country and the number of sampled households in each village is too small to be representative, these numbers are merely suggestive of possible patterns. There are promising new methodologies available for more accurate identification of village social and poverty outcomes on the basis of merged household survey and population census data. It would be worthwhile to explore the use of such

[5] Uttar Pradesh accounts for slightly less than 17 percent of India's population.

[6] Of course, this will depend upon the (administrative as well as political) cost of lower-level targeting.

methodologies to identify the districts and villages with the largest number of infant deaths in the country, so that public action could be better targeted to these districts and villages.

E. Mortality Patterns by Gender and Birth Order

Much has been written about sex differentials in infant mortality in India (Rosenzweig and Schultz 1982, Das Gupta 1987, Miller 1989). India is among the few countries in the world where female infants are at greater risk of death than male infants. The NFHS-2 data do not show a significant disparity in *average* male and female infant mortality rates, although this in itself is unusual since infant mortality rates for males typically tend to exceed those for females in most countries. Indeed, the NFHS-2 data show that the mortality rate for females is lower than that for males in the first month of life (neonatal mortality), achieves virtual parity by age one (infant mortality), and exceeds the mortality rate for males by age 5 (under-five mortality) (Table 1). It thus appears that as girls grow older, they lose their natural survival advantage over boys. This change in relative survival is more apparent in Figure 8, which plots the mortality rate for boys and girls by monthly age. The risk of mortality is observed to be greater for males than for females until age 12 months. However, the reverse is true from ages one to five. Parental neglect toward girls – symptomatic of the generally low social status of women – is an important cause of the gender disparity in child mortality. Girls are less likely to receive adequate food allocations and medical treatment for their illnesses than boys (Das Gupta 1987, Behrman and Deolalikar 1988, Filmer *et al.* 1998).

Another form of intra-household disparity in infant and under-five mortality rates that is observed in South Asia is birth-order disparity. In general, first- and second-born children tend to be more favored than higher-order children in the allocation of schooling, nutrition and health inputs by their parents. Table 2 suggests a non-linear pattern in mortality rates, with first-born children facing a higher risk of mortality than second- or third-born children, but fourth- or higher-order children facing the highest risk of mortality. The high mortality rate for first-born children reflects the largely biological risk of delivery complications for younger mothers, since nearly two-thirds of all first-born children in the NFHS-2 sample were born to mothers aged 20 years or younger. With control for mother's age at the time of a child's birth, a more linear relationship between child mortality rates and birth order is observed (Table 2). The risk of neonatal, infant and under-five mortality increases sharply for children of birth order 4 or greater.

Upon further disaggregation, an interesting pattern emerges. It is not just higher birth order that increases the risk of mortality for a child; instead, it is higher birth order combined with the fact of being a female. For example, while third or higher birth order males have only a 5% increased risk of neonatal mortality relative to first- or second-born males, the corresponding figure for females is 29% (Table 3). Third or higher birth order females have a nearly 50% higher rate of under-five mortality than first- or second-born females.

Another manner in which to view the interaction between birth order and sex is to look at the ratio of female to male infant or under-five mortality rate for children of different birth orders. Among first- and second-born children, the ratio of female to male neonatal mortality rate is 85%; however, for children of birth order 3 or higher, the ratio of female to male neonatal mortality is 105%. In the case of under-five mortality rate, the corresponding ratios are 99% and 121%, respectively.

F. More on Birth Order and Gender Disparities

How persistent is the intra-household discrimination against higher birth order girls across different social and economic groups? And how does mother's schooling influence the discrimination?

Social groups. It is clear from Table 4 that scheduled tribes differ from other social groups (e.g., scheduled castes, other backward castes, and forward castes) in three ways. First, they are the only social group among whom infant and under-five mortality rates are consistently (i.e., across all birth orders) lower for females than for males. In the case of the other three social groups, infant and under-five mortality rates for females exceed those for males for higher parity (greater than birth order three) children. For instance, the ratio of female to male infant mortality rates among higher birth order (3 or higher) children is only 85% for the scheduled tribes, as compared to 130%, 114% and 110% among the scheduled castes, other backward castes and forward castes, respectively.

Second, among scheduled tribes, there is virtually no disparity in infant mortality rates across children of different birth orders. (Indeed, if anything, the infant mortality rate for higher birth order children is 6% lower than that for lower birth order children in this group.) The higher birth order children do face a higher *under-five* mortality rate than lower birth order children within this group, but even this discrepancy is relatively small (only about 9%) and is observed only among males. In contrast, the disparity in infant and under-five mortality rates across lower and higher birth order children is significantly greater (20-40%) among the other social groups.

Third, scheduled tribes are the only social group among whom females of higher birth order do not have a significantly higher mortality rate than females of lower birth order. Among the other social groups, higher birth order girls typically have under-five mortality rates that are 40-70% higher than those of lower birth order girls.

Thus, the evidence certainly appears to suggest that, unlike other social groups, scheduled tribes do not discriminate (in the allocation of nutritional and health inputs) against female children, higher birth order children, and especially against higher birth order girls. Although the forward castes have the lowest overall rates of infant and under-five mortality, they have among the highest rates of observed discrimination against higher birth order girls. In this group, the under-five mortality rate for girls of birth order three or higher is 70% greater than that for girls of birth order one or two.

Economic groups. The NFHS-2 has the disadvantage of not containing data on household income or consumption expenditure. As such, it is not possible to analyze differentials in infant and under-five mortality across low- and high-income households. However, the NFHS has categorized households into three broad economic groups – low, medium and high living standards – based on their ownership of land and other assets (mainly consumer durables). Approximately, 38%, 46% and 15% of the sample households fall in the low, medium and high living standard categories.

As would be expected, both infant and under-five mortality rates are significantly lower among better-off households than among poor households (Table 5). The pattern of higher birth order females having higher mortality rates than both higher birth order males and lower birth order females is observed among both low and middle economic groups. However, among the best-off households, there is no evidence of discrimination against higher birth order females. For instance, the ratio of female to male under-five mortality rates even among children of birth order 3 or higher is only 102% among the high living standard households; the corresponding ratios for low and medium living standard households are 115% and 130%, respectively.

Maternal Literacy. To what extent is the discrimination against higher-order girls mitigated with maternal literacy? Table 6, which reports sex- and birth order-specific infant and under-five mortality rates for children with literate and illiterate mothers, indicates the huge beneficial effect of maternal literacy on child mortality rates. While both boys and girls benefit (in terms of having a lower risk of mortality) from having their mother literate, the benefit is much smaller for higher birth order girls. For instance, Figure 9 indicates that for first- or second-born children, the reduction in infant mortality associated with having a literate mother is 46% for boys and 50% for girls. However, for children of birth order 3 or higher, the difference is dramatic. Boys with literate mothers have an infant mortality rate that is 34% lower than boys with illiterate mothers, but for girls the difference in infant mortality is merely 19%.

What this also means is that intra-household discrimination against girls varies in interesting ways. For both literate and illiterate mothers, there is no evidence of son preference in the first two births. Indeed, among first- and second-born children, female infant mortality is lower than male infant mortality (a little bit more so for literate than for illiterate mothers). However, among children of birth order 3 or higher, there is a marked increase in the ratio of female to male infant mortality. Among illiterate mothers, the ratio of female to male infant mortality among birth order 3 or higher births is 1.09, while the comparable rate is as high as 1.34 among literate mothers. Thus, higher birth-order female infants are at a considerably higher risk of premature death than their higher birth-order brothers when their mothers are literate!

What might explain this unusual finding? Because literate mothers are much more likely than illiterate mothers to have fewer children and because there is a strong culturally-rooted preference for sons in India, literate mothers having three or more children are likely to be women who have only had daughters – and no sons – and are under (social or family) pressure to give birth to a son. Among this group of women, higher birth order daughters are thus likely to be unwanted children – facing neglect and risk of premature death.

G. Other Correlates of Under-Five and Infant Mortality

One problem with the previous analysis is that it does not control for the other correlates of infant and under-five mortality. In order to address this problem, we have used unit record data (at the level of a child) from the National Family Health Survey 1998-99 (NFHS-2) to estimate multivariate models of under-five and infant mortality.[7,8] The 'explanatory' variables included in the model include child-specific (sex and birth order), mother-specific (age at child's birth and literacy status), household-specific (caste; sex and literacy of household head; access to piped water, sanitation, and electricity; land ownership; and level of living standard[9]), village-specific (electricity supply, presence of sub-health center, availability of all-weather road, etc.), and district-specific (percent of children in district fully immunized). In addition, a full set of

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[7] Since the dependent variable is dichotomous (viz., whether or not a child dies within 12 months of its birth), the model has been estimated by the maximum-likelihood probit method.

[8] Infant mortality rates can be calculated from the NFHS-2 for the four-year period preceding the survey (i.e., 1994-98). See Annex B for a description of the data.

[9] The NFHS-2 is a rich data set, but it has the limitation that it does not contain household information on income or expenditure, both of which are widely used as measures of household welfare. However, the survey classified households into three categories of standard-of-living based on their ownership of assets and consumer durables – low, medium and high (IIPS 2001).

dummy variables for the state of residence are included to capture unobserved heterogeneity in mortality conditions across states. To test whether the determinants of mortality differ systematically by sex, both models include interaction terms between the sex of a child and every other right-hand side variable. The model has been subsequently re-estimated with all of the insignificant interaction variables dropped.

The estimates of these models are reported in Table 7. For the most part, the results on the determinants of under-five mortality are very similar to those on the determinants of infant mortality. As a result, we will discuss the under-five mortality results and note any significant differences observed in the case of infant mortality.

The large majority of independent variables in the model are significant in their association with both infant and under-five mortality. In addition, most results are intuitive. For instance, even after controlling for other variables, scheduled castes (SCs), scheduled tribes (STs), and other backward castes (OBC) have significantly higher under-five mortality than forward castes. The differences are large; for instance, controlling for other factors, the under-five mortality rate for STs exceeds that for forward castes by 16 deaths per 1,000 live births. The difference for SCs and OBCs is much smaller – 8 and 5 deaths per 1,000 live births.

The results also indicate strong inter-state differences in mortality even after controlling for household living standards, caste, maternal education, and infrastructure access. Since the excluded state category is Kerala, all the state dummy coefficients are positive, indicating that mortality rates in no state are lower than those in Kerala. Madhya Pradesh, Meghalaya, Rajasthan, Uttar Pradesh, and Orissa have the highest ‘innate’ under-five and infant mortality rates.

Maternal characteristics are strongly associated with the risk of child mortality. Controlling for other factors, the under-five mortality rate falls by about 4 deaths per 1,000 live births for each additional year that the mother delays having a child.[10] Likewise, children of literate mothers have an under-five mortality rate that is 14 deaths per 1,000 live births lower than that of children of illiterate mothers. The corresponding number for literacy status of the household head is 8½, indicating that mother's literacy is far more important to children's survival than literacy of the household head.

As would be expected, household living standards have a strong association with both under-five and infant mortality. Households enjoying a high standard of living have a significantly lower under-five mortality rate than households with a medium standard of living, and the latter in turn have a significantly lower risk of under-five and infant deaths than households with a low standard of living.

Infrastructure has important associations with mortality risk as well. Access to piped water, toilets, all-weather roads, and electricity are all significantly associated with either under-five or infant mortality. Interestingly, while households with access to electricity have an under-five mortality rate that is 6.5 deaths per 1,000 live births lower than households with no access to electricity, those households with access to electricity who reside in villages having a regular supply of electricity (6 or more hours per day) have an even lower under-five mortality rate (15.4 deaths), indicating the importance of regularity of electricity supply.

Among the health infrastructure variables, the presence of a sub-health center in a village is not associated with either under-five or infant mortality. It is unclear though whether the absence of a correlation indicates the poor quality and irrelevance of most sub-health centers or

[10] About 30 percent of births in the NFHS-2 occur to women under the age of 20.

whether it reflects the collinearity between the presence of a sub-health center in a village and the availability of physical infrastructure (e.g., electricity, piped water, all-weather road, etc.). On the other hand, the percentage of children in a district who are fully immunized has a significant (inverse) association with both under-five and infant mortality.

The empirical results suggest that being born as a twin is the strongest mortality risk factor. Children born as twins are nearly three times more likely to die under the age of five than children not born as twins. The greater mortality risk of twins has been well-established as a fact in the medical literature.

The results with respect to birth order and gender are interesting. Gender by itself is not associated with higher mortality risk, although birth order is. Each subsequent birth is associated with a significantly higher risk of mortality – more so for under-five mortality than for infant mortality (7.7 more deaths versus 2.2 more deaths per 1,000 live births). The results suggest that higher birth order children face the greatest risk of mortality (relative to lower birth order children) between the ages of one and five years – when breastfeeding has typically been replaced with solid foods. This suggests that the mortality differential between low and high birth order children might be originating in unequal allocations of food and nutrition to these children.

The interaction term between birth order and gender is significantly positive, indicating that higher birth order girls face significantly higher risk of mortality than higher birth order boys. While each subsequent male birth has a 8% greater risk of under-five mortality, the corresponding number for female births is 15%.

The associations between mortality, birth order and maternal literacy are also revealing. As noted earlier, a literate mother is associated with a significantly reduced risk of under-five mortality (by about 14 deaths per 1,000 live births).[11] The interaction term for maternal literacy and birth order is not significantly different from zero, indicating that both low and high birth order children benefits equally from a mother's literacy. The interaction between maternal literacy and a child's gender is significantly negative, suggesting that the beneficial effects of maternal literacy on mortality are greater for girls than for boys. For instance, while mother's literacy is associated with an increase in male under-five mortality of 14 deaths per 1,000 live births, the comparable number for female children is nearly three times as large – 37 deaths per 1,000 live births. Thus, girls benefit enormously (in terms of having vastly reduced risk of mortality) when their mothers are literate.

However, the triple interaction between gender, birth order and mother's literacy is significantly positive, suggesting that the beneficial effect of maternal literacy on girls' mortality risk is much greater for low than for high birth order girls. The beneficial effect of mother's literacy on female under-five mortality falls by 8.6 deaths per 1,000 live births for each subsequent birth.

[11] Note that the association between infant mortality and maternal schooling implied by the estimated equation may not reflect causality, since there is no control for unobserved endowments in the relationship. For instance, Behrman and Rosenzweig (2002) find that a positive significant association of mother's schooling on child schooling in cross-sectional estimates becomes significantly negative if data on identical twins are used to control for unobserved genetic and family background endowments, perhaps because more-schooled women – holding constant ability – spend more time in the labor force and less in child care. The available data do not permit extensive exploration of such possibilities.

H. Concluding Remarks

There are several interesting findings that emerge from this paper. First, the paper documents the large disparities in the levels of and changes in infant and under-five mortality across Indian states. Kerala has the lowest mortality rates, while Orissa has the highest. Interestingly, Bihar and Uttar Pradesh, which had among the highest infant mortality in the country in 1981, experienced some of the largest reductions in infant mortality over 1981-2000. At the other end, Andhra Pradesh and Karnataka had the slowest rate of infant mortality decline over the two decades. The intra-state variations in infant and under-five mortality are even greater than the inter-state variations.

The disparity in infant mortality rates results in a high geographical concentration of infant and child deaths in the country. Four states – Uttar Pradesh, Madhya Pradesh, Bihar and Rajasthan – together account for slightly more than one-half of all infant deaths in India. Data from the National Family Health Survey of 1998-99 are also suggestive of infant deaths in India being heavily concentrated in a relatively small number of districts and villages. For instance, in the period 1994-99, a mere 20% of the villages and 22.5% of the districts in the NFHS-2 sample with the largest number of infant deaths accounted for half of all infant deaths in the country.

Second, although overall under-five mortality does not differ significantly across boys and girls, there are important differences by age. The mortality rate for females is actually lower than that for males in the first month of life (neonatal mortality), achieves virtual parity by age one (infant mortality), and exceeds the mortality rate for males by age 5 (under-five mortality).

Third, higher birth order combined with the fact of being a female significantly increases the risk of infant and under-five mortality in India. For example, while third or higher birth order males have only a 5% increased risk of neonatal mortality relative to first- or second-born males, the corresponding figure for females is 29%. Third or higher birth order females have a nearly 50% higher rate of under-five mortality than first- or second-born females. The empirical results suggest that only two groups – scheduled tribes and households with high living standards – do not show significantly higher mortality for high birth order girls.

Fourth, the results also indicate that maternal literacy reduces the risk of mortality, particularly for girls. However, this beneficial effect of maternal literacy on girls' mortality risk is much smaller for high birth order girls. Indeed, higher birth-order girls are at a considerably higher risk of premature death than their higher birth-order brothers when their mothers are literate! This probably reflects the fact that literate mothers are much more likely than illiterate mothers to have fewer children. Combined with a strong culturally-rooted preference for sons, literate mothers having three or more children are likely to be women who have only had daughters – and no sons – and are under (social or family) pressure to give birth to a son. Among this group of women, higher birth order daughters are thus likely to be unwanted children – facing neglect and risk of premature death.

Fifth, the empirical results in this paper point to the importance of household living standards and infrastructure – access to piped water, toilets, all-weather roads, and regular electricity – in bringing about mortality reduction. Additionally, immunization coverage in a district has a significant (inverse) association with both under-five and infant mortality.

All of these results have important implications for policy. General economic growth (resulting in higher living standards), improved infrastructure, and greater child immunization coverage will be essential in lowering infant and under-five mortality rates in the country. However, these general policies will not be enough. Special attention will need to be paid to the problem of significantly higher mortality risk among higher birth order children, especially girls. It is worrisome that this group remains at significant risk of mortality even with the presence of a literate mother. The results with respect to the geographic concentration of infant deaths also indicate the importance of targeting mortality-reducing interventions to the states, districts and villages having the highest rates of infant mortality and the slowest rates of mortality decline.

Table 1: Neonatal, infant, and under-five mortality rates, by sex, 1994-98

	Mortality rates (per 1,000 live births)		
Sex	Neonatal	Infant	Under-five
Males	46.4	67.8	90.0
Females	42.1	66.8	95.9

Table 2: Neonatal, infant and under-five mortality rates (per 1,000 live births), by mother's age at birth and birth order, 1994-98

	Neonatal mortality			Infant mortality			Under-five mortality		
Birth order	20 years & under	Over 20 years	All mothers	20 years & under	Over 20 years	All mothers	20 years & under	Over 20 years	All mothers
First-born	35.5	58.7	49.5	49.8	81.7	69.5	60.2	101.2	86.5
Second-born	33.6	54.5	40.6	47.8	78.3	58.3	63.1	111.5	81.2
Third	30.5	54.9	34.0	51.7	86.5	57.0	76.0	126.6	84.6
Fourth	42.8	74.5	44.2	68.6	99.0	70.1	95.5	162.6	99.1
Fifth or higher	52.0	54.5	52.0	85.3	115.7	85.4	121.4	178.1	121.7
All birth orders	39.1	57.4	44.3	61.4	81.5	67.4	86.0	108.4	92.8

Table 3: Neonatal, infant and under-five mortality rates (per 1,000 live births), by birth order and sex, 1994-98

	Neonatal mortality			Infant mortality			Under-five mortality		
Birth order	Male	Female	Both	Male	Female	Both	Male	Female	Both
1-3	45.8	39.0	42.5	65.0	59.6	62.4	84.5	83.8	84.2
4 or higher	47.9	50.2	49.0	74.9	84.5	79.5	102.7	123.9	112.9
All	46.4	42.1	44.3	67.8	66.8	67.4	90.0	95.9	92.8

Table 4: Infant and under-five mortality rates (per 1,000 live births), by child's sex, child's birth order, and social group, 1994-98

Infant mortality rates												
	Scheduled Tribe			Scheduled Caste			Other Backward Caste			Forward Caste		
Birth order	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
1 or 2	92.6	72.3	82.8	72.7	69.9	71.4	67.1	61.7	64.5	53.4	50.2	51.9
3 or higher	84.3	72.0	78.3	76.6	99.8	87.6	78.1	89.2	83.5	68.1	74.9	71.4
All	89.8	72.2	81.3	74.0	79.6	76.7	70.1	69.4	69.7	57.3	56.8	57.0
Ratio*	91.1	99.7	94.6	105.4	142.7	122.7	116.4	144.5	129.4	127.6	149.2	137.6
Under-five mortality rates												
	Scheduled Tribe			Scheduled Caste			Other Backward Caste			Forward Caste		
Birth order	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
1 or 2	111.9	112.9	112.4	96.6	103.4	99.9	86.8	85.2	86.0	70.6	66.2	68.5
3 or higher	128.8	117.0	123.0	106.8	143.0	124.4	106.1	126.2	115.9	89.0	112.2	100.2
All	117.7	114.3	116.0	100.0	116.7	108.1	92.4	97.2	94.7	75.7	79.2	77.4
Ratio*	115.0	103.6	109.5	110.6	138.4	124.6	122.1	148.1	134.7	126.1	169.6	146.3

Table 4 (cont'd): Infant and under-five mortality rates (per 1,000 live births), by child's sex, child's birth order, and social group, 1994-98

	Ratio of female to male infant mortality rates				Ratio of female to male under-5 mortality rates			
Birth order	Scheduled Tribe	Scheduled Caste	Other Backward Caste	Forward caste	Scheduled Tribe	Scheduled Caste	Other Backward Caste	Forward Caste
1 or 2	78.1	96.3	92.0	94.0	100.8	107.0	98.1	93.8
3 or higher	85.4	130.2	114.2	109.9	90.8	133.9	118.9	126.0
All	80.4	107.6	99.0	99.1	97.1	116.7	105.2	104.6

Notes: * Ratio of the mortality rate of first or second birth order children to the mortality rate of children of birth order 3 or higher.

Source: Author's calculations from NFHS-2 unit record data.

Table 5: Infant and under-five mortality rates per 1,000 live births,

by child's sex, child's birth order, and household standard of living, 1994-98

	Infant mortality rates								
	Low std. of living			Medium std. of living			High std. of living		
Birth order	Male	Female	Both	Male	Female	Both	Male	Female	Both
1 or 2	85.0	70.9	78.2	61.6	61.8	61.7	38.9	33.8	36.5
3 or higher	89.8	94.1	91.8	64.5	80.8	72.5	42.2	44.9	43.4
All	86.8	79.3	83.2	62.4	67.2	64.7	39.4	35.2	37.4
Ratio	105.6	132.7	117.4	104.7	130.6	117.5	108.5	132.7	118.7
	Under-five mortality rates								
	Low std. of living			Medium std. of living			High std. of living		
Birth order	Male	Female	Both	Male	Female	Both	Male	Female	Both
1 or 2	110.5	112.3	111.4	79.3	79.0	79.2	50.7	41.4	46.3
3 or higher	123.1	141.2	131.7	91.4	118.5	104.9	54.2	55.3	54.7
All	115.1	122.6	118.7	82.9	91.2	86.9	51.2	43.5	47.6
Ratio	111.4	125.7	118.3	115.2	149.9	132.4	106.9	133.7	118.2
	Ratio of female to male infant mortality rates				Ratio of female to male under-5 mortality rates				
Birth order	Low	Medium	High	All	Low	Medium	High	All	
1 or 2	83.4	100.3	86.9	91.7	101.6	99.6	81.7	99.1	
3 or higher	104.7	125.1	106.3	113.0	114.7	129.7	102.2	120.6	
All	91.4	107.6	89.3	98.6	106.5	110.0	84.8	106.6	

Table 6: Infant and under-five mortality rates per 1,000 live births, by child's sex, child's birth order, and mother's literacy, 1994-98

Infant mortality rate

	Illiterate mother			Literate mother		
Birth order	Male	Female	Both	Male	Female	Both
1 or 2	83.9	78.7	81.4	45.6	39.7	42.8
3 or higher	80.6	87.5	83.9	53.0	71.2	61.5
All	82.6	82.1	82.4	46.7	44.0	45.4
Ratio	96.1	111.2	103.1	116.2	179.3	143.7

Under-5 mortality rates

	Illiterate mother			Literate mother		
Birth order	Male	Female	Both	Male	Female	Both
1 or 2	108.5	111.0	109.7	56.1	50.6	53.5
3 or higher	111.1	131.6	121.1	70.3	91.7	80.3
All	109.5	119.1	114.2	58.4	57.1	57.8
Ratio	102.4	118.6	110.4	125.3	181.2	150.1

	Ratio of female to male infant mortality rates		Ratio of female to male under-5 mortality rates	
Birth order	Illiterate	Literate	Illiterate	Literate
1 or 2	93.8	87.1	102.3	90.2
3 or higher	108.6	134.3	118.5	130.4
All	99.4	94.2	108.8	97.8

Table 7: Maximum likelihood probit estimates of the probability of an infant or under-five death in the four years preceding the survey, 1994-98

Independent Variable	*Under-5 mortality*		*Infant mortality*	
	Coeff.	*Asym. z-ratio*	*Coeff.*	*Asym. z-ratio*
Whether Scheduled Caste*	**0.0080**	2.65	**0.0063**	1.84
Whether Scheduled Tribe*	**0.0160**	3.25	**0.0167**	3.00
Whether Other Backward Caste*	**0.0053**	1.92	**0.0072**	2.29
Mother's age at child's birth	**-0.0040**	-10.03	**-0.0021**	-4.82
Whether household has piped water*	-0.0043	-1.40	**-0.0096**	-2.17
Whether household has no access to toilet*	**0.0085**	1.79	**0.0109**	2.74
Whether index birth was a twin birth*	**0.2767**	27.06	**0.2521**	20.52
Whether household has access to electricity*	**-0.0065**	-2.27	-0.0037	-1.13
Whether household has access to electricity x Whether electricity supply is irregular in village	**-0.0089**	-2.63	-0.0032	-0.84
Whether village of residence has a sub primary health center*	0.0010	0.42	0.0009	0.34
Whether village of residence is connected by an all-weather road*	**-0.0037**	-1.66	-0.0011	-0.45
Whether household head widow/widower*	-0.0027	-0.62	-0.0004	-0.08
Child's birth order	**0.0077**	6.71	**0.0022**	1.73
Child's birth order x Whether child's mother is literate*	-0.0020	-1.03	-0.0031	-1.42
Whether mother of child is literate*	**-0.0140**	-2.30	-0.0059	-0.90
Whether head of household is literate*	**-0.0085**	-3.72	-0.0037	-1.44
Acres of cultivated land operated by household	-0.0001	-0.95	0.0000	-0.34
Whether household enjoys low living standard (excluded variable)*				
Whether household enjoys medium living standard*	**-0.0173**	-7.50	**-0.0161**	-4.69
Whether household enjoys high living standard*	**-0.0279**	-6.33	**-0.0176**	-3.59
% of children in district who are fully immunized	**-0.0001**	-2.21	**-0.0002**	-3.17

Table 7: Maximum likelihood probit estimates of the probability of an infant or under-five death in the four years preceding the survey, 1994-98

Independent Variable	*Under-5 mortality*		*Infant mortality*	
	Coeff.	*Asym. z-ratio*	*Coeff.*	*Asym. z-ratio*
Whether child is female?*	0.0015	0.12	0.0073	0.62
Female child dummy,* interacted with:				
Whether Scheduled Tribe*	**-0.0159**	-2.79	**-0.0159**	-2.55
Mother's age at child's birth	**-0.0010**	-1.72	**-0.0013**	-2.11
Whether household has piped water*			**0.0112**	1.76
Whether household has no access to toilet*	**0.0120**	1.80		
Child's birth order	**0.0065**	4.04	**0.0062**	3.45
Child's birth order x Whether child's mother is literate*	**0.0086**	3.19	**0.0082**	2.74
Whether mother of child is literate*	**-0.0231**	-2.83	**-0.0222**	-2.62
Whether household enjoys medium living standard*			**0.0159**	3.25
Dummy variable for residence in (Kerala is the excluded state):				
Andhra Pradesh	**0.0779**	5.42	**0.0738**	4.22
Assam	**0.0624**	4.09	**0.0808**	4.19
Bihar	**0.0683**	5.04	**0.0575**	3.60
Goa	0.0291	0.46	0.0166	0.24
Gujarat	**0.0834**	5.36	**0.0857**	4.49
Haryana	**0.0785**	4.61	**0.0790**	3.80
Himachal Pradesh	0.0361	1.58	0.0438	1.60
Jammu and Kashmir	**0.0809**	2.63	**0.0995**	2.67
Karnataka	**0.0567**	3.85	**0.0493**	2.82
Madhya Pradesh	**0.1300**	8.40	**0.0995**	5.46
Maharashtra	**0.0635**	4.51	**0.0503**	3.05
Manipur	0.0483	1.37	0.0408	1.01

Table 7: Maximum likelihood probit estimates of the probability of an infant or under-five death in the four years preceding the survey, 1994-98

Independent Variable	*Under-5 mortality*		*Infant mortality*	
	Coeff.	*Asym. z-ratio*	*Coeff.*	*Asym. z-ratio*
Meghalaya	**0.1176**	4.13	**0.1210**	3.59
Mizoram	0.0668	1.08	0.0670	0.92
Nagaland	**0.0677**	1.99	0.0457	1.16
Orissa	**0.0958**	6.16	**0.0850**	4.54
Punjab	**0.0890**	5.12	**0.0888**	4.19
Rajasthan	**0.1129**	7.26	**0.0849**	4.67
Sikkim	0.0158	0.14	0.0138	0.10
Tamil Nadu	**0.0554**	3.81	**0.0573**	3.27
West Bengal	**0.0359**	2.76	**0.0404**	2.57
Uttar Pradesh	**0.1077**	7.81	**0.0854**	5.29
Delhi	0.0303	0.71	0.0606	1.21
Arunachal Pradesh	**0.0806**	1.96	0.0784	1.61
Tripura	**0.0664**	2.37	0.0522	1.54
Number of observations	82,120		47,412	
Chi-squared test	2,356		967	
Log likelihood ratio	-25,929		-11,821	

Note: All coefficients are expressed as marginal effects (i.e., the change in probability of being underweight with a one-unit change in the right-side variable.) * implies that the variable is dichotomous. All standard errors are robust and have been corrected for heteroscedasticity using the White method.

Infant mortality rate, by rural/urban sector, 1971-2000

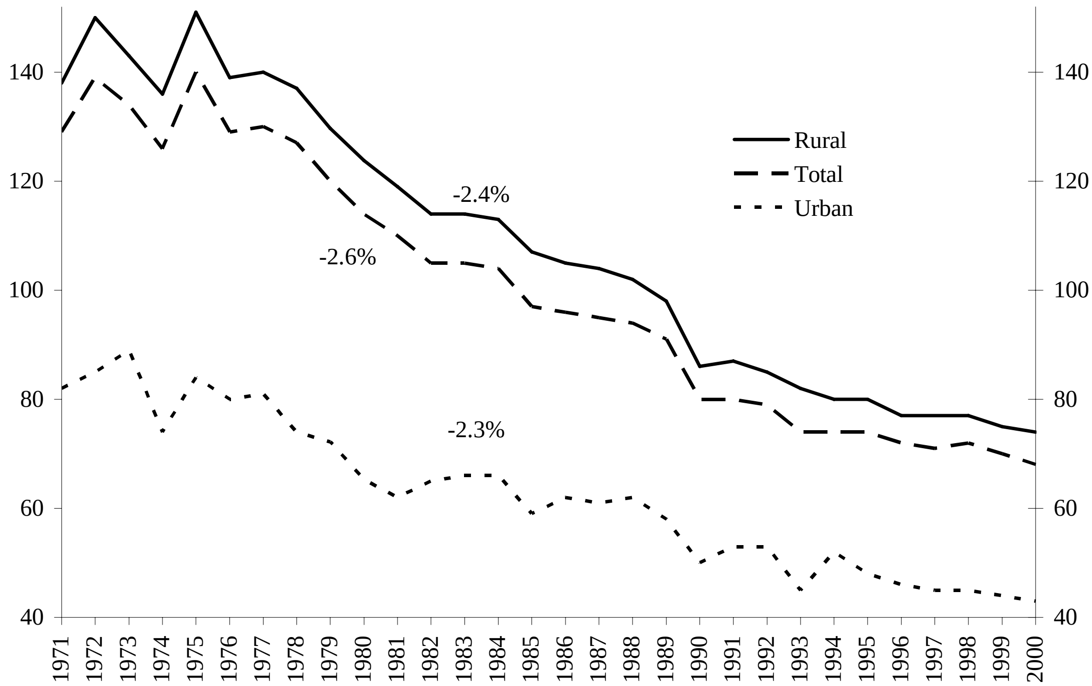


Figure 1

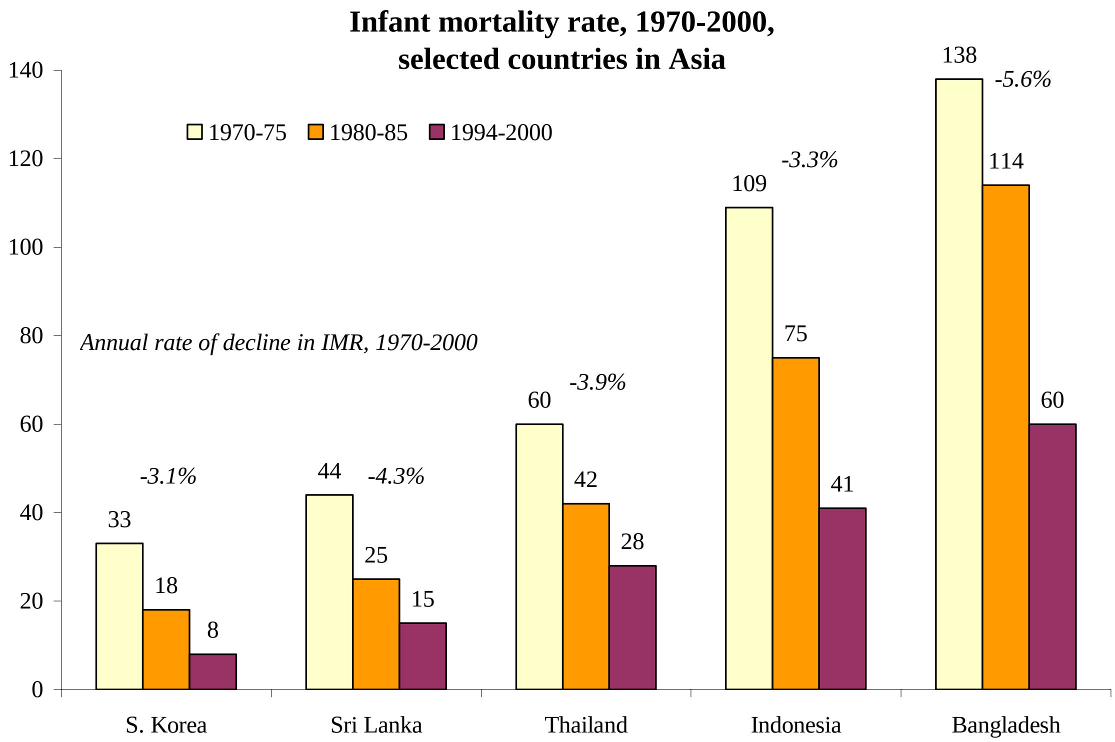

Infant mortality rate, 1970-2000,
selected countries in Asia
1970-75
1980-85
1994-2000
Annual rate of decline in IMR, 1970-2000
140
120
100
80
60
40
20
0
33
18
8
-3.1%
44
25
15
-4.3%
60
42
28
-3.9%
109
75
41
-3.3%
138
114
60
-5.6%
S. Korea
Sri Lanka
Thailand
Indonesia
Bangladesh

Figure 2

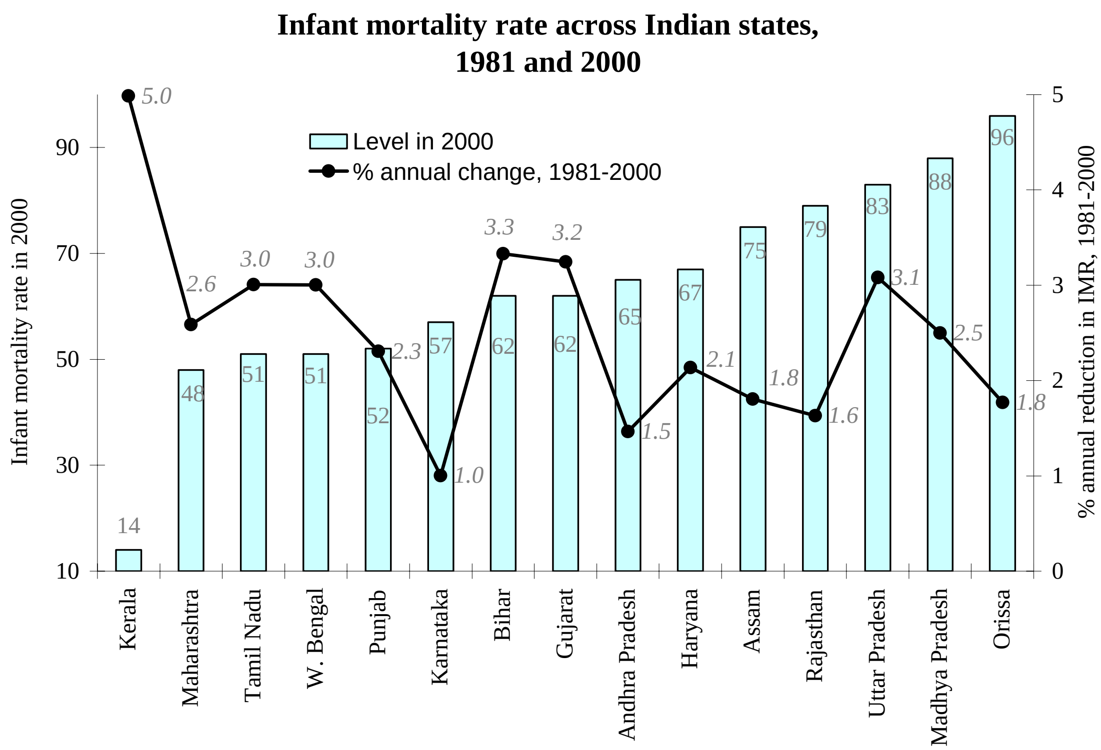

Infant mortality rate across Indian states,
1981 and 2000
Level in 2000
% annual change, 1981-2000
Infant mortality rate in 2000
% annual reduction in IMR, 1981-2000
Kerala
Maharashtra
Tamil Nadu
W. Bengal
Punjab
Karnataka
Bihar
Gujarat
Andhra Pradesh
Haryana
Assam
Rajasthan
Uttar Pradesh
Madhya Pradesh
Orissa
14
48
51
51
52
57
62
62
65
67
75
79
83
88
96
5.0
2.6
3.0
3.0
2.3
1.0
3.3
3.2
1.5
2.1
1.8
1.6
3.1
2.5
1.8

Figure 3

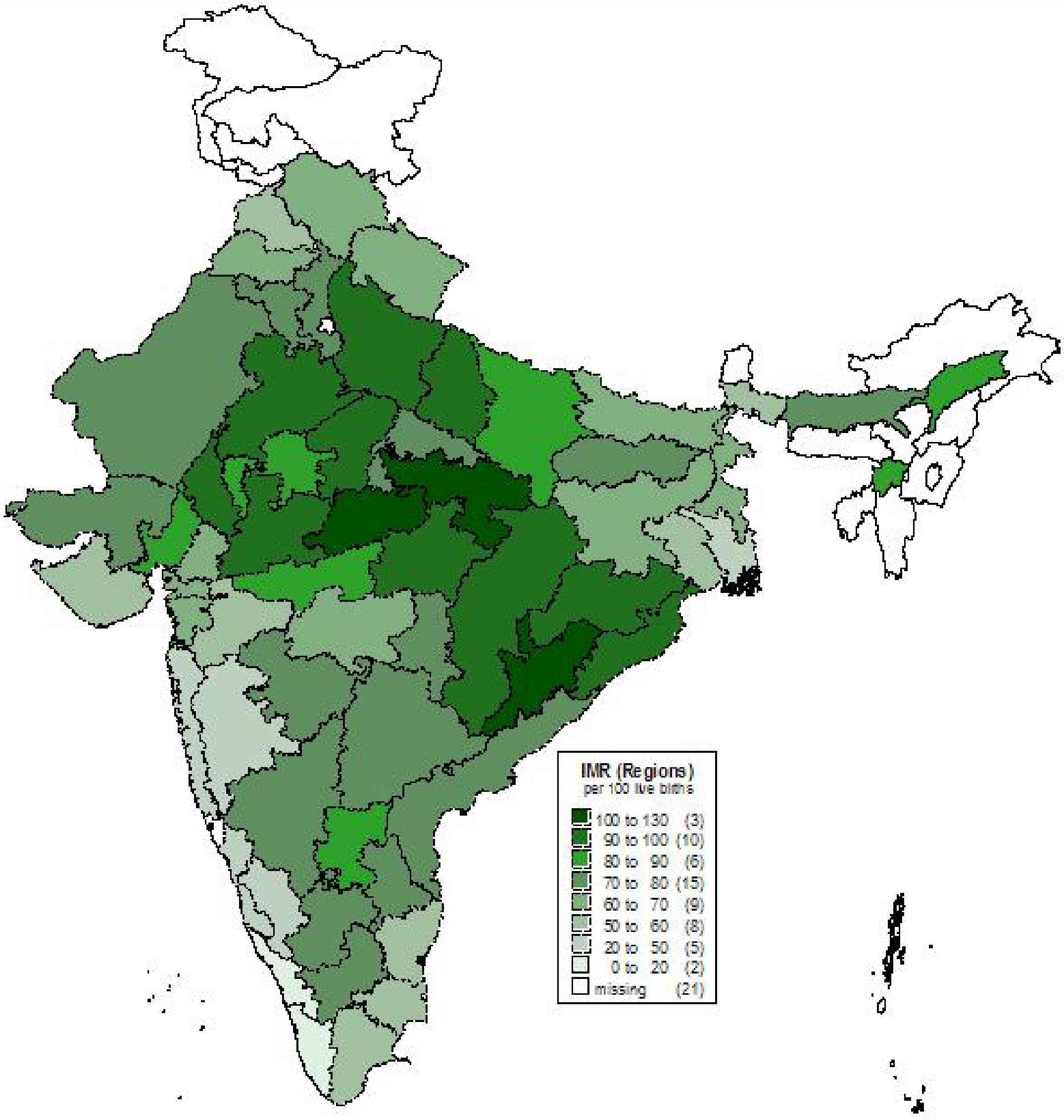


Figure 4: Regional Estimates of Infant Mortality Rate (per 1,000 live births), 1997-99

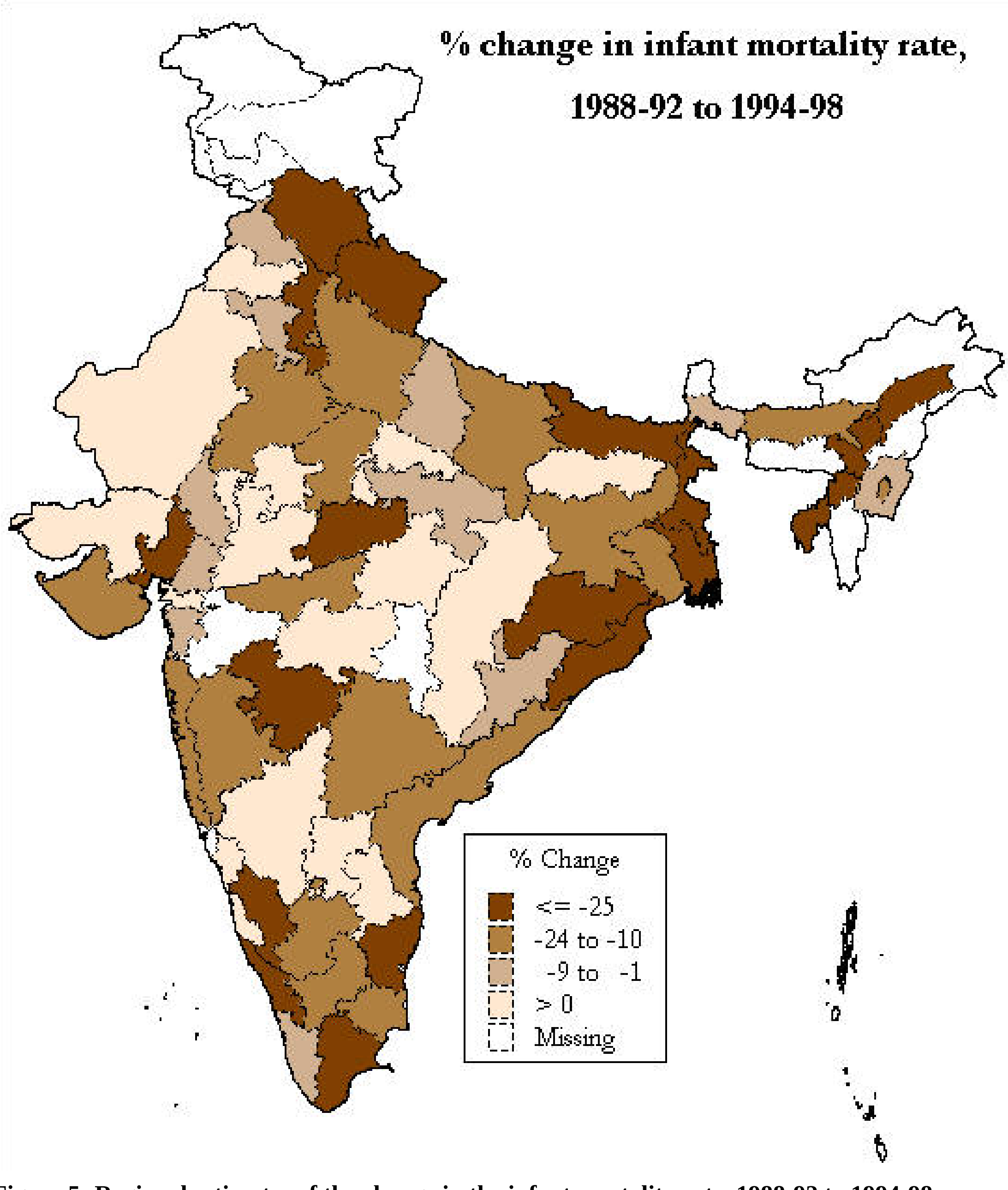
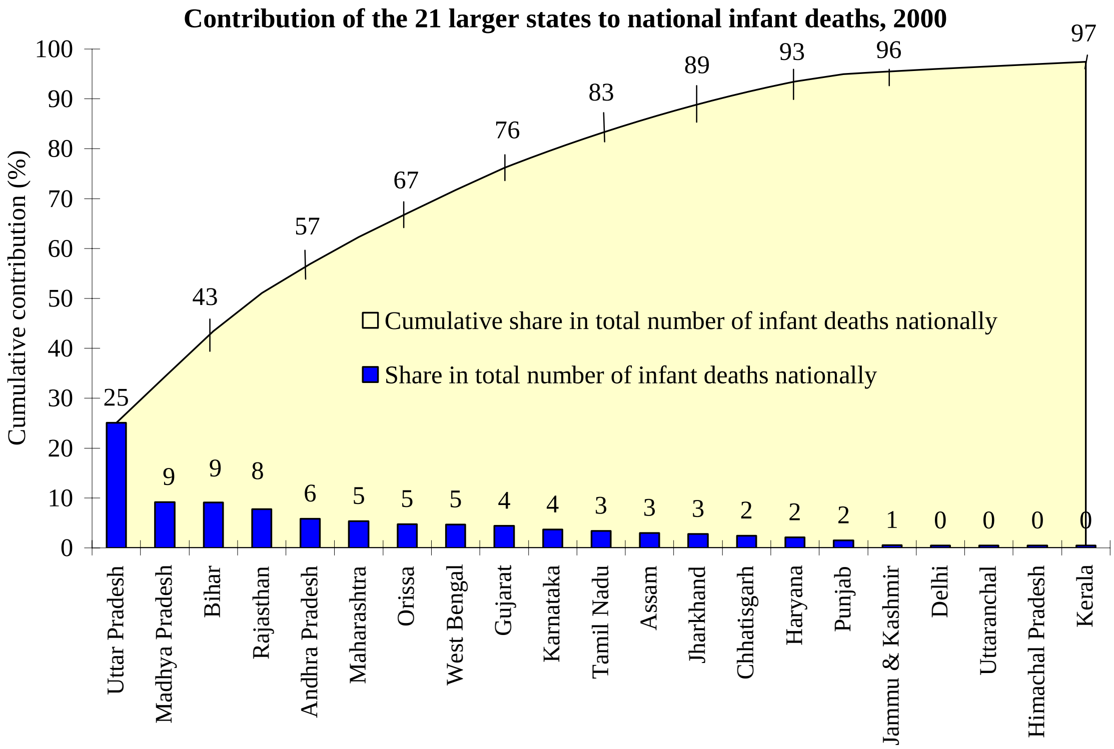


Figure 5: Regional estimates of the change in the infant mortality rate, 1988-92 to 1994-98



Contribution of the 21 larger states to national infant deaths, 2000
Cumulative contribution (%)
100
90
80
70
60
50
40
30
20
10
0
25
43
57
67
76
83
89
93
96
97
9
9
8
6
5
5
5
4
4
3
3
3
2
2
2
1
0
0
0
0
Cumulative share in total number of infant deaths nationally
Share in total number of infant deaths nationally
Uttar Pradesh
Madhya Pradesh
Bihar
Rajasthan
Andhra Pradesh
Maharashtra
Orissa
West Bengal
Gujarat
Karnataka
Tamil Nadu
Assam
Jharkhand
Chhatisgarh
Haryana
Punjab
Jammu & Kashmir
Delhi
Uttaranchal
Himachal Pradesh
Kerala

Figure 6

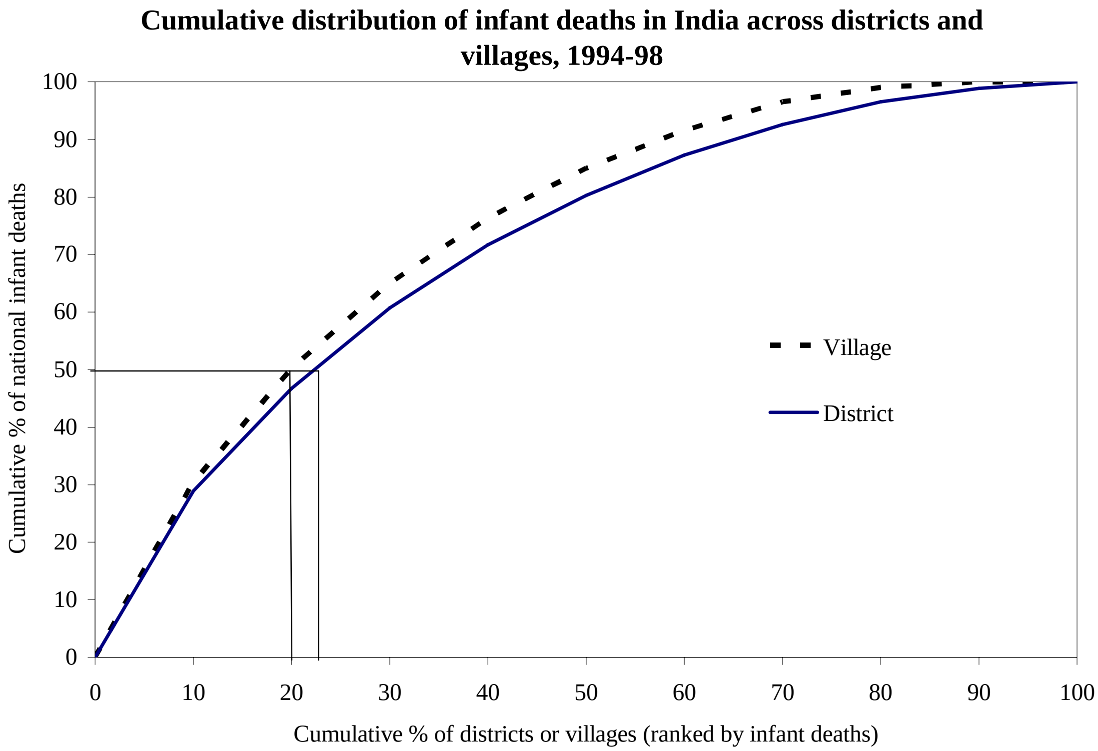

Cumulative distribution of infant deaths in India across districts and villages, 1994-98
100
90
80
70
60
50
40
30
20
10
0
Cumulative % of national infant deaths
Village
District
0
10
20
30
40
50
60
70
80
90
100
Cumulative % of districts or villages (ranked by infant deaths)

Figure 7

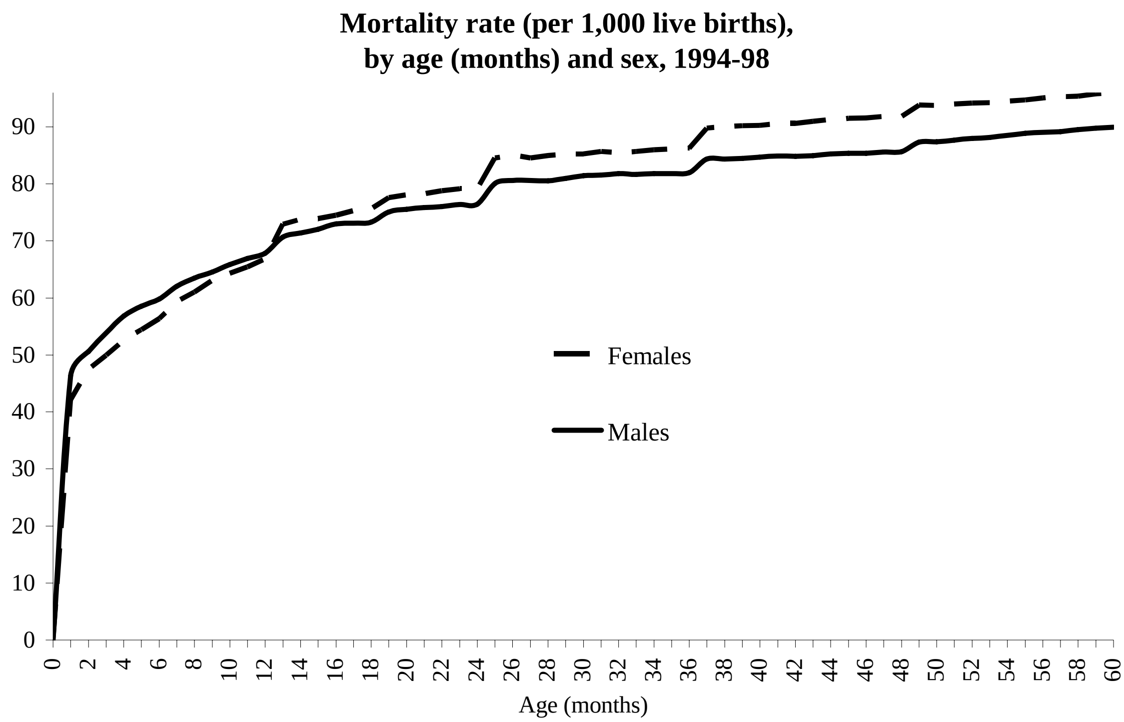

Mortality rate (per 1,000 live births),
by age (months) and sex, 1994-98
0
10
20
30
40
50
60
70
80
90
Females
Males
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
Age (months)

Figure 8

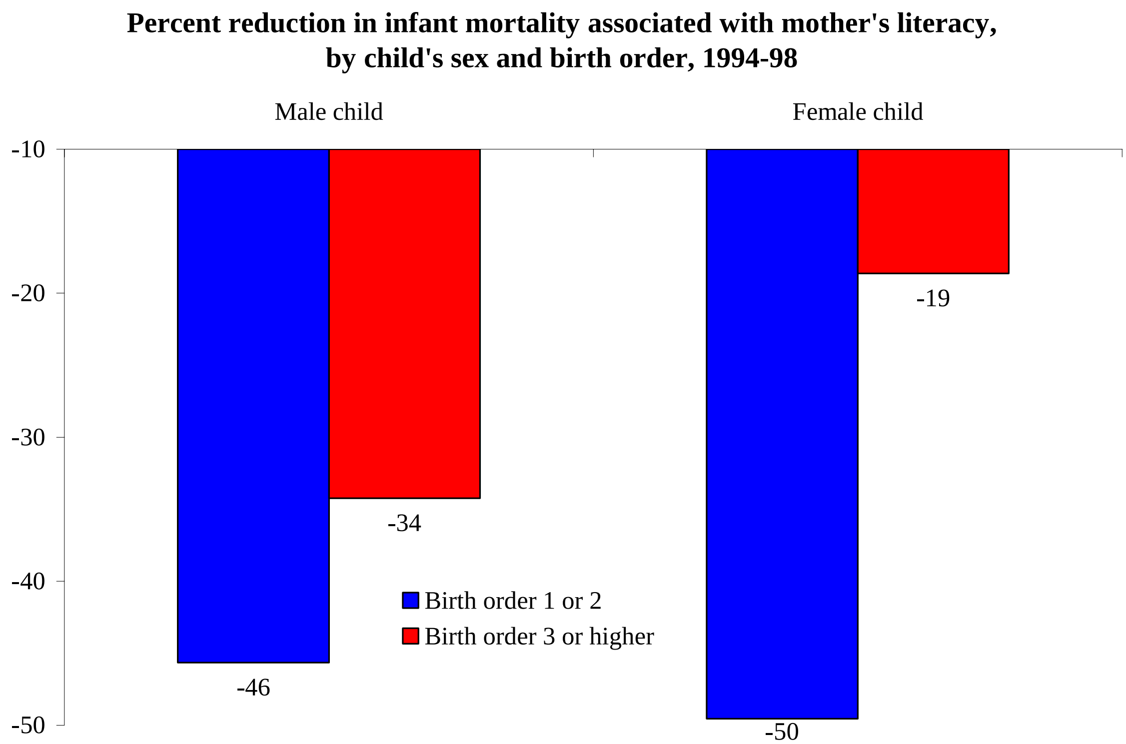

Percent reduction in infant mortality associated with mother's literacy,
by child's sex and birth order, 1994-98
Male child
Female child
-10
-20
-30
-40
-50
-46
-34
-50
-19
Birth order 1 or 2
Birth order 3 or higher

Figure 9

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