Trends in Child Mortality in India

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To assess India's recent trends in child mortality rates and disparities and identify ways to reduce child mortality and wealth-related health disparities, we analyzed three years of data from India's National Family Health Survey related to child mortality. Nationally, declines in average child mortality were statistically significant, but declines in inequality were not. Urban areas had lower child mortality rates than rural areas but higher inequalities. Interstate differences in child mortality rates were significant, with rates in the highest-mortality states four to six times higher than in the lowest-mortality states. However, child mortality in most states declined.

Key words: *Child mortality, Disparities, Trends.*

In 2008, roughly 1.8 million children died in India, more than in any other country, accounting for about 21% of child deaths worldwide [1]. In developing countries, children in poorer families are at greater risk of disease, undernutrition, and deaths [2,3]. Research is needed to identify inequalities in mortality rates along the socioeconomic gradient for efficient resource allocation [4,5]. One measure to track changes in population health along the dimensions of goodness (averages) and fairness (equity) is the Health Achievement Index (HAI), a summary measure that combines the Concentration Index (CI) (a common measure of socioeconomic inequalities), and the average level of health [6,7].

We assessed national and state trends in mean child mortality rates, CI, and HAI in India during 1992, 1998, and 2005, and tested for changes in mean child mortality rates and CI. Results of this secondary analysis are presented here.

METHODS

We used household survey data from three waves of India's National Family Health Survey (NFHS) (1992-1993, 1998-1999, and 2005-2006) [8-10] for the empirical analysis. For convenience, we henceforth refer to these periods as 1992, 1998, and 2005.

We estimated mortality rates in children age 5 and younger, the CI, and the HAI and computed separate estimates for rural and urban areas using the Synthetic Cohort Life Table approach [11]. Following Rutstein and Rojas, we adopted the following age segments to calculate the individual probabilities of dying (completed ages, in months): 0, 1-2, 3-5, 6-11, 12-23, 24-35, 36-47, and 48-59. This approach allows full use of recent data and is specific to the periods.

At national and state levels, we used the wealth index to compute the CI, as described in the literature [12]. The CI can range in value from -1 to +1, with 0 indicating no wealth-related health inequality. Negative CI values represent ill health in that they indicate a disproportionate burden of mortality among the poorest sections of society; the larger the value, the greater the inequality. The product of the mean mortality rates and the CI yields the HAI, a weighted average of the health levels of people in the sample, in which higher weights are attached to poorer people [13]. While the concentration curve is not a convenient measure of inequality for comparison, the CI, which is based on the concentration curve, quantifies the degree of socioeconomic inequality in a health variable [6,7].

We computed t-statistics to test for statistically significant differences in the mean mortality rates and inequalities (CI) between 1992 and 1998 and 1998 and 2005 at national and state levels. For the three states formed in 2000 (Uttarkhand, Jharkhand, and Chhattisgarh), we used estimates from the respective "parent" states (Uttar Pradesh, Bihar, and Madhya Pradesh) for the earlier years.

RESULTS

Overall, with the exception of a few small states, mean child mortality rates declined at national and state levels between 1992 and 1998 and 1998 and 2005 (***Table* I, *Fig*. 1**). Nationally, mean child mortality rates declined

significantly between 1992 and 1998 and 1998 and 2005. Mean child mortality for the 10 states that together account for roughly 60% of the annual birth cohort, also declined. However, changes in inequality were not uniform. Nationally, inequalities increased slightly between 1992 and 1998 and declined slightly between 1998 and 2005, with similar trends in rural India; there was a statistically significant decline in mean mortality for both urban and rural India and a corresponding decline in HAI between 1992 and 1998 and 1998 and 2005. Urban areas had lower child mortality rates than rural areas, but inequalities (CIs) were higher in urban areas in all three years.

Results were mixed for the states with the largest birth cohorts (*Web Fig*.1). Although HAI decreased uniformly, few had statistically significant changes in inequality. Among all states, mean child mortality, inequalities, and HAI varied significantly (*Table* I). In 1992, eight states had mean child mortality rates and HAI higher than the national average of 108.75/1,000 live births and 127.28/1,000 live births, respectively, while 19 states had inequalities worse than the national average of -0.170.

Child mortality varied significantly among the states, with the lowest rates in states like Kerala (32/1,000 live births) and the highest in states like Uttar Pradesh (141/1,000 live births). In 1998, 10 states had mean mortality rates and HAIs higher than the national average of 94.25/1,000 live births and 112.31/1,000 live births, respectively, while 23 states had inequalities worse than the national average of 0.192. In 1998, child mortality rates declined in both Kerala (19/1,000 live births) and Uttar Pradesh (122/1,000 live births). In 2005, nine states had mean child mortality rates and HAIs higher than the national average of 74.1/1,000 live births and 87.22/
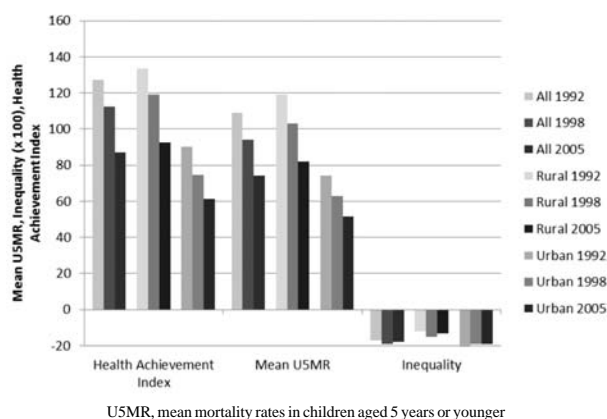
1,000 live births, respectively, while 19 states had inequalities worse than the national average of -0.178. Child mortality rates in Kerala declined further in 2005 to 16/1,000 live births, while those of Uttar Pradesh declined to 96/1,000 live births.

Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh, and the recent additions Chhattisgarh, Jharkhand, and Uttarkhand. Chhattisgarh, Madhya Pradesh, and Rajasthan fared marginally worse on all dimensions of health achievement between 1992 and 1998 (*Table* I), but the differences were not statistically significant except for the change in inequality for Rajasthan. Between 1998 and 2005, all the BIMARU states except Bihar had statistically significant declines in child mortality; both Bihar and Uttar Pradesh had statistically significant declines in inequality. The exception was Uttarkhand, where inequality increased between 1998 and 2005. Between 1992 and 1998, five states had statistically significant increases in child mortality; 12 states showed a statistically significant decline in child mortality. Four states had worse inequalities in 1998 than in 1992, while three improved in this measure. All states had lower child mortality in 2005 than in 1998, with statistically significant declines in 17 states. However, six states had statistically significant higher inequalities in 2005, while four had lower inequalities.

DISCUSSION

India's national child mortality rates mask the vast underlying differences in child health achievement in urban and rural areas among the states and along the socioeconomic gradient. In 2006, India had a birth cohort of more than 27 million. By aggregating data over such large cohorts, with significant socioeconomic, geographic, and political differences between states, we lose important information [14]. Detailed information regarding the performance of the individual states is important to enable policy prescriptions subnationally.

Although child health achievement improved nationally between the periods we compared, the mean child mortality rate and CI presented stark contrasts. While mean child mortality rates have declined significantly, inequalities have not declined commensurately. However, nationally, declines in child mortality were not necessarily accompanied by worsening inequality. Although mean child mortality rates declined in both rural and urban India, significant rural-urban differences persisted, with 50% to 60% higher rates in rural areas. Lack of potable water and sanitation infrastructure is a major cause of infant and child mortality in rural areas [3,14].

U5MR, mean mortality rates in children aged 5 years or younger

FIG 1. *Mean mortality rates in children aged ≤5 years, inequality, and health achievement indices in India, nationwide and in rural states and urban populations, 1992, 1998, and 2005.*

TABLE I State-level Trends in Mean Mortality Rates of Children Aged 5 Years or Younger, Health Achievement, and Inequality in India, 1992, 1998, and 2005.

Year	1992			1998			2005		
	Mean			Mean			Mean		
State	CI	U5MR	HAI	CI	U5MR	HAI	CI	U5MR	HAI
Andhra Pradesh	-0.09	91	99.01	-0.15	85	98.32	-0.09	63	68.59
Arunachal Pradesh	-0.39	72	99.42	-0.22	97	117.97	-0.12	87	97.43
Assam	-0.1	141	156.01	-0.12	89	99.77	-0.1	85	93.09
Bihar	-0.1	127	139.43	-0.16	105	121.07	-0.1	85	93.1
Chhattisgarh	-0.13	130	146.08	-0.17	137	159.17	-0.12	90	100.95
Delhi	-0.22	82	100.1	-0.24	55	68.58	-0.17	47	54.67
Goa	-0.2	39	46.57	-0.05	46	48.33	-0.19	20	24.11
Gujarat	-0.19	103	122.88	-0.2	84	101.11	-0.25	61	75.76
Haryana	-0.14	98	111.51	-0.21	76	92.64	-0.13	52	59.39
Himachal Pradesh	-0.05	69	72.77	-0.09	43	46.55	-0.2	42	50.29
Jammu and Kashmir	-0.1	59	64.82	-0.13	80	90.3	-0.15	51	58.73
Jharkhand	-0.1	127	139.43	-0.16	105	121.07	-0.11	93	103.12
Karnataka	-0.15	87	100.3	-0.17	70	81.27	-0.17	54	63.44
Kerala	-0.22	32	39.22	-0.05	19	19.95	-0.17	16	19.04
Madhya Pradesh	-0.13	130	146.08	-0.17	137	159.17	-0.17	94	109.38
Maharashtra	-0.2	70	84.36	-0.14	58	66.33	-0.26	46	58.39
Manipur	-0.2	62	74.26	-0.2	56	67.03	-0.29	41	53.51
Meghalaya	-0.02	87	88.67	-0.14	121	138.49	-0.18	70	82.96
Mizoram	-0.08	29	31.04	-0.14	55	62.41	-0.16	52	60.88
Nagaland	0.12	21	18.13	-0.07	64	68.77	-0.19	64	76.36
Orissa	-0.07	130	140.08	-0.16	104	120.4	-0.15	90	103.65
Punjab	-0.12	68	76.21	-0.22	71	87.23	-0.16	52	60.6
Rajasthan	-0.08	102	110.6	-0.17	114	133.42	-0.12	85	95.35
Sikkim	–	–	–	-0.14	71.1	81.6	-0.07	40	42.57
Tamil Nadu	-0.31	87	113.4	-0.17	63	73.62	-0.24	36	44.01
Tripura	-0.19	104	123.4	-0.1	51	56.65	-0.25	59	74.08
Uttar Pradesh	-0.14	141	160.26	-0.17	122	141.92	-0.1	96	105.9
Uttarkhand	-0.14	141	160.26	-0.17	122	141.92	-0.37	57	77.91
West Bengal	-0.12	99	111.03	-0.15	68	78.07	-0.08	59	64.14

CI, inequality; HAI, health achievement; U5MR, mean mortality rates in children aged 5 years or younger.

In India, health care is the responsibility of state governments [15]. Although mortality rates declined across all states during 1992 to 2005, a slight increase in some states in 1998 was associated with the drop in public health care expenditure (PHCE). In 1990, India's PHCE was 1.3% of gross domestic product (GDP) but had declined to 0.9% by 1999 [16]. Among the states, Bihar and Uttar Pradesh had the lowest PHCE. However, the more troubling trend is the widening of the gap in child mortality across states. Increasing the gross state domestic product (GSDP) (and the corresponding PHCE) of the states lagging in child health achievement is not easy; according to Ahluwalia, [17] Bihar, Uttar Pradesh, and Orissa had poor GSDP growth in the 1990s. Bhat and Jain, [15] have shown that all state governments have set targets for PHCE expenditures as a fraction of their GSDP, but they are inadequate to achieve the United Nations Millennium Development Goals.

Nationally, we found no evidence of significant

WHAT IS ALREADY KNOWN?

• Crude measures of disparities in child mortality at the state level are known.

WHAT THIS STUDY ADDS?

• Child mortality declined in most states but interstate differences in child mortality were significant, with rates in the highest-mortality states four to six times higher than in lowest-mortality states.

improvements in wealth-related inequalities in child mortality rates. At the state level, inequalities increased in more places than they decreased during 1992 to 1998 and 1998 to 2005. In addition, the poorest performing states failed to reduce wealth-related inequalities in child mortality, an important finding that suggests that improvements in economic opportunities do not necessarily lead to improvements in health care infrastructure [18]. The increasing inequality in 1992 to 1998 corresponds to the general contraction of public expenditures between 1992 and 1996 [15].

Although previous studies indicate that economic growth is associated with declines in average child mortality rates nationwide, [19-21] this association may not hold subnationally. Specifically, Maharashtra and Gujarat were ranked just below Punjab and Haryana in income in the early 1990s, but post 1991, their income accelerated at the fastest pace; [22] both states demonstrated consistent declines in mean child mortality, but inequality increased in Maharashtra in these rates during 1998 to 2005. The premise that economic growth increases inequality of health outcomes subnationally is reinforced with data from Tamil Nadu; the declines in child mortality in this state were accompanied by an increase in inequalities. Tamil Nadu had one of the highest income growth rates in the 1990s.

In light of our findings, the government launch of the National Rural Health Mission (NRHM) and the National Urban Health Mission (NUHM) in 2005 is particularly timely. The NRHM was launched [22] to improve rural health by targeting phased increases in funding for the health sector of 2% or 3% of the GDP. The immediate expected outcome is reduced child mortality. India also developed NUHM to provide accessible and affordable health care to nearly 220 million of India's urban poor in 429 cities. Our findings suggest that the NRHM and NUHM could identify the districts with the highest number of child deaths in the high-mortality states and target them with low-cost interventions like vaccinations, oral rehydration salts, and vitamin A supplementation.

Despite reductions in national child mortality in India in 1992 to 2005, significant rural-urban, interstate, and intrastate disparities remain. In addition, although we found no conclusive evidence of a tradeoff between "goodness" and "fairness," the results indicate that, on average, declines in child mortality rates do not automatically reduce wealth-related inequalities in these rates.

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