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Article

Mind the gap: Temporal trends in inequalities in infant and child mortality in India (1992–2016)

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1. Introduction

Reduction in Infant and under 5 deaths has been a priority across the developing world but has met with varying success both between and within countries (Boerma et al., 2008). In spite of its economic progress and home to more than 18 percent of the world's children (UN, 2017), India has made slow progress with respect to child mortality as compared to other countries in the region (WHO, 2016). India finds herself 48th out of 89 on infant mortality rate (UN, 2017) and has slipped down to 131 among the 188 countries ranked in terms of human development (UNDP, 2016). It is therefore not surprising that India failed to achieve its MDG 5 target which has huge implications as almost 20% of world's infant deaths are experienced in India (UNICEF, 2017).

Infant mortality rates and U5MR in India have declined at a gradual pace from 86 per thousand live births and 119 per thousand live births in 1992 to 41 per thousand live births and 50 per thousand live births in 2016 respectively (IIPS, 1995; IIPS & ICF, 2017). However, such averages mask the inequalities that exist across socio-economic groups, gender, educational status, place of residence, religion, caste, etc. For example, with respect to socio-economic groups, U5MR among the WI groups (poorest vs. richest) varied from 118 to 39 in 2005-6 (IIPS and Macro, 2007). Similarly, children born in tribal area experiences U5 mortality one and half times than those of other groups (Baru & Bisht, 2010). More recent data shows that although the under-five mortality rate is estimated at 39 at national level, it varies from 43 in rural areas to 25 in urban areas. Among the bigger States/UTs, it varies from 11 in Kerala to 55 in Madhya Pradesh (SRS, 2016). Similarly, at the national level, IMR is reported to be 34 and varies from 38 in rural areas to 23 in urban areas (SRS, 2016).

Although it is common to see studies that analyse health inequalities in general and inequalities in child mortality between rich and poor in specific, there are few studies that take into consideration the temporal trends while addressing inequalities in child mortality (Shaw et al., 2005). Therefore the purpose of this paper is to analyse the trend in inequalities in IMR in Indian states over 1992–2016 time frame using NHFS 1 to 4 survey data. This paper uses IMR for further analysis (e.g. decomposition analysis) as it has proved itself as a sensitive indicator for assessing the overall development of a country over number of years (Stockwell et al., 1988; Baru & Bisht, 2010).

India, with a population of 1.34 billion (UN, 2017) is one of the fastest growing economies in the world and makes an interesting case-study for analysing inequalities in child mortality. With its economic liberalisation policy on the one hand and number of pro poor policy initiatives within the health sector, it would be useful to examine the trends in inequalities in child mortality. In past, number of authors have suggested that inequalities are increasing in India both between and within states and across socio-economic groups (Deaton & Drèze, 2009; Baru & Bisht, 2010). With the latest NHFS - 4 series data for 2015-16 being recently released in public domain, it would be timely to examine temporal trends in inequalities in child mortality in India.

2. Methods

The data used in this study was taken from National Family Health Survey series from 1992 and includes the recent round conducted in India in 2015-16 (NFHS-4) and like previous surveys provides information on population, health and nutrition for every State / Union territory in India. However, district- level data has been provided for the first time in this latest survey. All women age 15–49 and men age 15–54 in the selected sample households were eligible for interviewing. NFHS-4 gathered information from 601,509 households, 699,686 women, and 103,525 men (IIPS & ICF, 2017). All analysis in the present paper was performed on kids file which carries the information about retrospective maternity history of child birth and death that took place five years prior to the survey date. In the present analysis, there were 259,627 births born between 2010 and 2016. Never married woman and multiple births have been dropped from the sample so in total there remained 254,938 births for final analysis. We have also merged the sample for Union territories into their nearby states like Andaman and Nicobar Island and Pondicherry was merged into Tamil Nadu; Dadar & Nagar Haveli was merged to Maharashtra; Daman & Diu to Gujarat;

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Laksdweep to Kerala; and Chandigarh to Punjab. For further analysis on WI groups (bottom 20 percent poorest and top 20 percent richest), it was necessary to merged the sample for the states of Goa into Maharashtra; Sikkim, Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya into North East.in order to get enough sample for analysis.

The dependent variable for the present study is considered as infant death which is coded as 1 “if the death occurred less than 1 year ”and 0 “otherwise”. The births which took place preceding five years from the date of survey has been considered for the analysis. The following independent variables has been taken: sex of the child (male/female), mother’s age at child’s birth into six categories (15–19/20–24/25–29/30–34/35–39/40–50), mother’s education (illiterate/ primary/ secondary/ higher), region, residence (rural/urban), birth Interval (1st birth order/two or more birth order and less than 24 months/ two or more birth order and more than 24 months). All analyses were performed in STATA software version 13.1.

3. Concentration index and its decomposition

The concentration index (Kakwani, 1977, 1980), attempts to estimate the degree of socioeconomic inequality in health (Wagstaff, van Doorslaer, & Paci, 1989) and is commonly used to compare the degree of socioeconomic-related inequality in child mortality (Wagstaff, 2000). In the present paper, an attempt was made to capture inequality in infant deaths related to inequality in socio-economic condition through concentration Index. The concentration index is defined as twice the area between the concentration curve and the line of equality (the 45-degree line) (Van Doorslaer & Koolman, 2004; Kakwani, Wagstaff, & Van Doorslaer, 1997). Negative value of the index implies disproportionate concentration of the health variable (infant death in our case) among the poor, and while the opposite is true for its positive values and it lies below the line of equality. For computation, a more convenient formula for the concentration index defines it in terms of the covariance between the infant death, ID, and the fractional rank, r_i ($ri = i/N$ which is the fractional rank of ith individual in the living standards distribution with $i = 1$ for the poorest and $i = N$ for the richest), in the living standards distribution (Jenkins, 1988; Kakwani, 1980; Lerman & Yitzhaki, 1989).

$$C = \frac{2}{\mu} COV(ID, r) \tag{1}$$

Wagstaff et al. (2003) proposed a methodology to decompose socioeconomic inequality in infant mortality into its determinants and showed that for any linear regression model linking the health variable of interest, y, to a set of k health determinants, x_k:

$$y_i = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i \tag{2}$$

where ε is an error term. Given the relationship between yi and x_{ki} in Eq. (2), the concentration index for y (C) can be written as:

$$C = \sum_K \frac{\beta_k \bar{x}_k}{\mu} C_k + \frac{G\, C_\varepsilon}{\mu} \tag{3}$$

where μ is the mean of y, $\bar{x}_k$ is the mean of x_k, C_k is the concentration Index for x_k. In the last term (which can be computed as a residual), GC_ε is the generalized concentration index for ε_i. Eq. (3) shows that C can be thought of as being made up of two components. The first is the deterministic, or ‘explained’, component and the second is a residual, or ‘unexplained’, component that cannot be explained by systematic variation in the x_k across socioeconomic groups.

In our analysis, infant mortality is a binary variable taking value either 0 or 1, depending on whether the infant survives or not in the 12 months following birth. We applied non-linear logit model which is intrinsically non-linear in the probability of death but linear in the propensity to infant death, Hence, we use this for the linear

Table 1
Relative change in inequalities in infant and under five mortality among WI groups over survey periods.

India & States	Relative Change NFHS-1 to NFHS-3		Relative Change NFHS-1 to NFHS-4		Relative Change NFHS-3 to NFHS-4	
	IMR	U5MR	IMR	U5MR	IMR	U5MR
India	**-25**	**-28**	**-51**	**-56**	**-35**	**-39**
Poorest	-25	-25	-47	-52	-30	-36
Poorer	-30	-32	-53	-59	-34	-39
Middle	-29	-36	-57	-63	-39	-42
Richer	-26	-33	-55	-60	-40	-40
Richest	-23	-28	-53	-55	-38	-38
Assam	**-24**	**-34**	**-48**	**-59**	**-33**	**-39**
Poorest	-6	-24	-42	-55	-38	-40
Poorer	-34	-38	-52	-64	-28	-41
Middle	-33	-45	-63	-72	-44	-49
Richer	-9	-22	-62	-67	-58	-58
Richest	-61	-51	-30	-37	81	28
Bihar	**-37**	**-34**	**-54**	**-59**	**-27**	**-38**
Poorest	-49	-42	-63	-66	-27	-42
Poorer	-43	-39	-56	-63	-23	-39
Middle	-35	-40	-62	-69	-40	-48
Richer	-7	-11	-47	-59	-44	-53
Richest	23	-2	-50	-58	-60	-57
Chhattisgarh	**-10**	**-8**	**-35**	**-39**	**-28**	**-33**
Poorest	-23	-14	-37	-38	-18	-28
Poorer	-7	-9	-29	-37	-24	-30
Middle	39	-3	-17	-36	-40	-34
Richer	-16	-7	-36	-29	-24	-24
Richest	-18	-29	-18	-26	0	3
Gujarat	**-15**	**-26**	**-52**	**-58**	**-43**	**-43**
Poorest	0	-14	-62	-62	-61	-56
Poorer	-18	-21	-51	-56	-41	-45
Middle	-24	-37	-60	-65	-47	-44
Richer	-5	-25	-46	-56	-43	-41
Richest	-4	-16	-27	-44	-24	-34
Jharkhand	**-2**	**2**	**-40**	**-48**	**-39**	**-49**
Poorest	-16	-12	-45	-53	-34	-47
Poorer	15	10	-50	-56	-57	-60
Middle	6	-12	-34	-51	-37	-45
Richer	-55	-54	-68	-67	-28	-29
Richest	18	20	-7	-23	-21	-36
Kerela	**-43**	**-52**	**-79**	**-82**	**-63**	**-62**
Poorest	-51	-66	-100	-100	-100	-100
Poorer	-29	-46	-85	-77	-79	-57
Middle	-19	-3	-62	-70	-54	-69
Richer	-42	-53	-79	-82	-64	-62
Richest	-13	-28	-65	-65	-60	-52
Maharashtra	**-19**	**-30**	**-57**	**-61**	**-47**	**-44**
Poorest	25	9	-65	-66	-72	-69
Poorer	-35	-49	-42	-51	-11	-5
Middle	-23	-31	-65	-65	-55	-49
Richer	-31	-41	-58	-65	-39	-41
Richest	-18	-23	-52	-49	-41	-33
Madhya Pradesh	**-17**	**-29**	**-46**	**-55**	**-35**	**-37**
Poorest	-25	-38	-48	-58	-31	-32
Poorer	-5	-25	-38	-55	-34	-40
Middle	-47	-49	-62	-65	-29	-32
Richer	-10	-32	-41	-54	-34	-32
Richest	-25	-25	-45	-46	-27	-28
Odisha	**-43**	**-31**	**-63**	**-59**	**-34**	**-40**
Poorest	-42	-24	-58	-52	-27	-36
Poorer	-41	-33	-66	-64	-42	-46
Middle	-55	-52	-70	-72	-34	-40
Richer	-53	-43	-77	-75	-52	-56
Richest	-49	-54	-74	-72	-49	-41
Rajasthan	**-5**	**-13**	**-44**	**-51**	**-41**	**-43**
Poorest	16	5	-33	-40	-42	-43
Poorer	-15	-21	-39	-50	-29	-37
Middle	-13	-24	-47	-56	-39	-43
Richer	-3	-16	-53	-56	-51	-48
Richest	-19	-24	-52	-56	-41	-42
Tamil Nadu	**-47**	**-53**	**-72**	**-73**	**-47**	**-44**
Poorest	-37	-49	-64	-73	-42	-47
Poorer	-42	-44	-76	-72	-59	-50
Middle	-49	-57	-73	-77	-47	-46

(*continued on next page*)

Table 1 (*continued*)

India & States	Relative Change NFHS-1 to NFHS-3		Relative Change NFHS-1 to NFHS-4		Relative Change NFHS-3 to NFHS-4	
	IMR	U5MR	IMR	U5MR	IMR	U5MR
Richer	-64	-65	-65	-60	-2	15
Richest	-35	-35	-65	-68	-47	-51
Uttar Pradesh	**-29**	**-31**	**-45**	**-50**	**-22**	**-28**
Poorest	-35	-35	-49	-53	-22	-28
Poorer	-40	-41	-53	-58	-21	-29
Middle	-22	-29	-44	-52	-28	-33
Richer	-30	-35	-42	-49	-17	-22
Richest	-17	-19	-35	-41	-21	-27
Uttarakhand	**-25**	**-36**	**-42**	**-55**	**-23**	**-30**
Poorest	-6	-2	5	-30	13	-29
Poorer	10	-17	-36	-52	-42	-42
Middle	-22	-35	-40	-51	-23	-24
Richer	-24	-39	-37	-52	-18	-22
Richest	-68	-69	-69	-74	-2	-13
West Bengal	**-36**	**-39**	**-62**	**-66**	**-41**	**-43**
Poorest	-42	-37	-53	-58	-18	-34
Poorer	-39	-45	-67	-69	-46	-44
Middle	-41	-51	-68	-73	-44	-44
Richer	-12	-30	-71	-74	-67	-63
Richest	-48	-51	-85	-87	-72	-73
Haryana	**-44**	**-45**	**-61**	**-63**	**-30**	**-33**
Poorest	-50	-40	-35	-23	28	28
Poorer	-46	-46	-60	-62	-26	-29
Middle	-58	-57	-53	-61	12	-9
Richer	-34	-43	-63	-67	-45	-41
Richest	-49	-49	-64	-64	-30	-30

Note: All mortality estimates are based on 10 years birth history.

decomposition method.

$$L_n\ odds_{infant\ Deaths} = \alpha_i + \sum \beta_i x_i + \varepsilon_i \tag{4}$$

Since the inequality in predicted infant death will be obtained for the observed values of the X variable, attention is focused on the first term in the decomposition equation, i.e. the predicted inequality as measured by $\widetilde{C}_y$.

$$C_y = \sum_k \frac{\beta_k \overline{x}_k}{\mu} C_k \tag{5}$$

4. Results

Table 1 presents the relative change in inequalities in infant and under five mortality among WI groups over the survey periods from NHFS-I to 3, NHFS 3 to 4 and NHFS-1 to 4. It can be observed that during NHFS-I to 3 survey period, relative change in inequalities among poorest to richest groups (pro-poor distribution) was observed in Assam, Maharashtra, Gujarat, Odisha, Rajasthan, Uttarakhand, West Bengal whereas during NHFS 1 to 4 survey period pro poor distribution in infant mortality was observed in rest of the states including Assam, Maharashtra, and Gujarat. Only 4 states namely Odisha, Rajasthan, Uttarakhand, West Bengal continued to experience inequality in infant mortality in favour of the richest group.

It is also important to note the magnitude of relative change during the survey periods. For example, during NHFS-1 to 3 survey period, Assam and Uttarakhand experienced widening of inequality gap between the poorest and richest group (10x) whereas minimal gap was noted in WB. Similarly, in NHFS-1 to 4 survey period widening of inequality gap between the poorest and richest group was observed mainly in Uttarakhand.

Table 2 presents the relative inequalities in child mortality among WI groups from NHFS-1 o 4 survey periods. As is commonly observed, national averages mask the huge disparities that may exist among groups. For example, in NHFS-I, the average IMR was 59, and varied from 10 in Uttarakhand to 77 in Jharkhand. States like Chhattisgarh, Gujarat, Jharkhand, Kerala, and Madhya Pradesh had high relative inequalities among poorest and richest WI groups. In NHFS-3, in addition to the above states, number of new states like Assam Maharashtra, Odisha, Uttarakhand, West Bengal reported high relative inequalities. Finally, there appears to be some improvement in NHFS 4 survey period where States like Assam, Gujarat, Maharashtra showed pro-poor distribution. However, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, Uttarakhand, West Bengal (WB) continue to experience high relative inequalities.

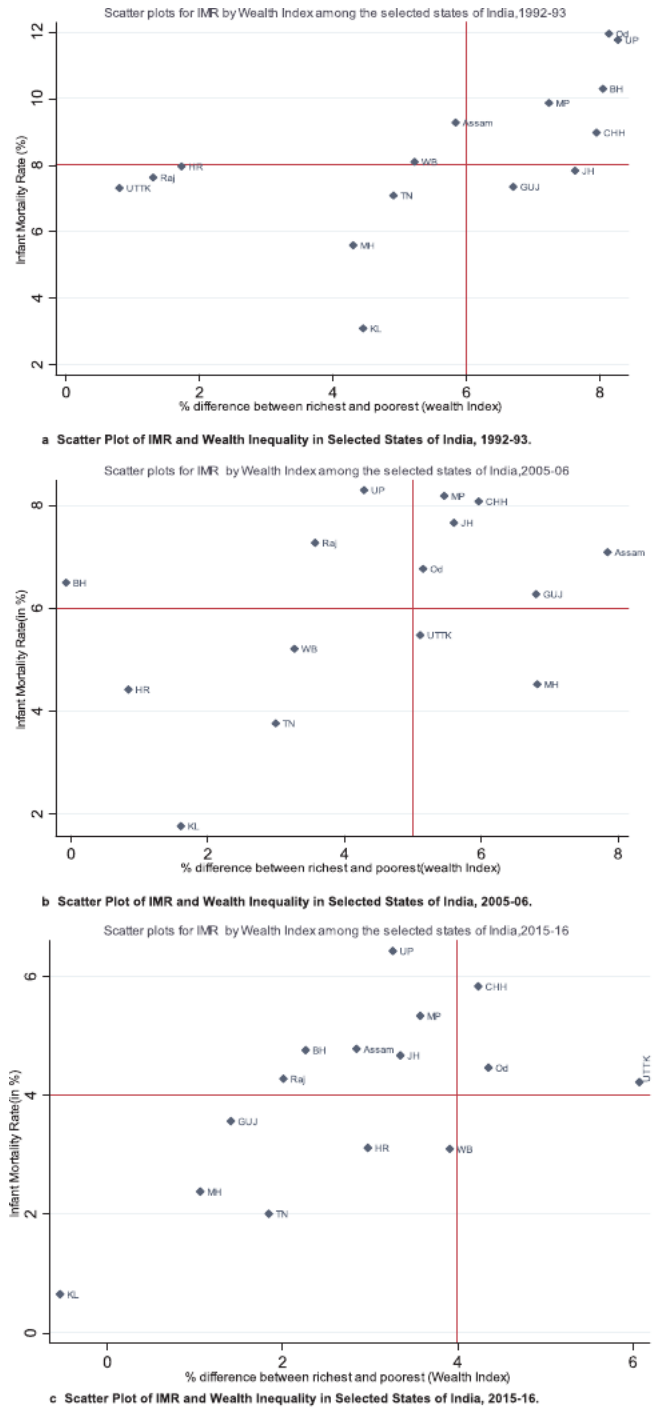
Table 2
Relative change in inequalities across NFHS-I to NHFS-IV survey periods.

India & States	NFHS-1 (relative change poorest & richest)		NFHS-2 (relative change poorest & richest)		NFHS-3 (relative change poorest & richest)		NFHS4 (relative change poorest & richest)	
	IMR	U5MR	IMR	U5MR	IMR	U5MR	IMR	U5MR
India	**-59**	**-65**	**-63**	**-70**	**-58**	**-66**	**-63**	**-67**
Assam	-57	-71	-29	-44	-82	-81	-48	-60
Bihar	-58	-62	-58	-62	1	-35	-44	-53
Chhattisgarh	-66	-65	-49	-61	-64	-71	-56	-59
Gujarat	-66	-67	-55	-67	-68	-68	-36	-51
Jharkhand	-77	-81	-65	-76	-67	-75	-61	-69
Kerela	-74	-78	-56	-67	-54	-54	**#DIV/0!**	**#DIV/0!**
Maharashtra	-56	-59	-62	-71	-71	-71	-40	-38
Madhya Pradesh	-60	-73	-63	-75	-60	-67	-57	-65
Odisha	-59	-61	-74	-81	-65	-76	-75	-78
Rajasthan	-18	-32	-52	-62	-42	-50	-41	-49
Tamil Nadu	-58	-68	-53	-62	-56	-58	-60	-61
Uttar Pradesh	-57	-63	-58	-65	-46	-54	-45	-53
Uttarakhand	-10	-24	-45	-62	-70	-76	-73	-71
West Bengal	-55	-62	-45	-59	-59	-70	-86	-88
Haryana	-21	-27	-44	-33	-21	-39	-57	-67

Scatter plots were drawn to identify the differentials in infant mortality among WI groups is presented in Fig. 1**a to c** for NHFS-1, NHFS-3 and NHFS-4 survey periods. The vertical and horizontal red lines represent the Indian national levels, which are useful comparisons for the high vs. low IMR and percentage difference between the WI within the states simultaneously. The Y-axis represents IMR and the X-axis indicates WI. The top two cells depict states that have a high IMR, whereas states in the lower two cells experience low IMR. The states on the two left cells represent a low difference between the rich and poor and those on the right side of the red line represent a high variation between rich and poor.

It can be observed from Fig. 1a that during NHFS-I states in the top right hand quadrant represent the worst performing states (e.g. Odisha, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, and Bihar) both in terms of high IMR and high differentials in infant mortality between rich and poor. Whereas Jharkhand and Gujarat had IMR below national average but had high socio-economic differentials. Similarly, during NHFS-3, new states were added to the top right hand quadrant namely Jharkhand, Assam and Gujarat whereas Uttar Pradesh and Bihar were no longer in that category. Lastly, during NHFS-4 it can clearly be seen that only 3 states namely, Odisha, Chhattisgarh and Uttarakhand were the worst performing states both in terms of high IMR and high differentials between rich and poor. Kerala has consistently performed well and is an excellent example of low infant mortality with low differentials among WI group.

Table 3 shows the percentage distribution of infant deaths among bottom 20 percent poorest and top 20 percent richest population. It was observed that there were 3339 infant deaths and 726 infant deaths among poorest and among richest population respectively. Infant deaths was higher among males than females both among poorest and richest. Among poorest, of the total infant deaths, most deaths occurred



a Scatter Plot of IMR and Wealth Inequality in Selected States of India, 1992-93.

b Scatter Plot of IMR and Wealth Inequality in Selected States of India, 2005-06.

c Scatter Plot of IMR and Wealth Inequality in Selected States of India, 2015-16.

Fig. 1. a–c: Scatter Plots for NHFS-I, III and IV. Fig. 1a: Scatter Plot of IMR and Wealth Inequality in Selected States of India, 1992-93. b: Scatter Plot of IMR and Wealth Inequality in Selected States of India, 2005-06. c: Scatter Plot of IMR and Wealth Inequality in Selected States of India, 2015-16.

to women in the age group 20 to 29 years while among richest it took place to the women in age 25 to 34 years. Among poorest mothers, 64 percent of the total infant deaths occurred to illiterate women while more than 85 percent infant deaths among richest occurred to women with secondary and higher educated women. Almost 96 percent of infant deaths among poorest occurred in rural areas while more than 60 percent infant deaths among richest took place in urban areas. Schedule Tribes (ST) and Schedule Castes (SC) contribute to over 45% of total infant deaths among the poorest group whereas their contribution is less than 15% in richest group. Both poorest and richest have higher

Table 3
Distribution of Infant deaths between bottom 20 percent poorest and top 20 percent richest population by various background characteristics, India, 2015-16.

Covariates	Infant Deaths (in %)	
	Poorest	Richest
Child's Sex		
Male	56.2	59.6
Female	43.8	40.4
Mother's Age (at child's birth)		
15–19	2.3	0.6
20–24	28.2	20.1
25–29	35.9	42.5
30–34	17.3	24.4
35–39	9.4	10.5
40–50	6.9	1.9
Mother's Education		
No education	63.7	7.11
Primary	16.6	6.33
Secondary	19.0	54.72
Higher	0.7	31.84
Place of Residence		
Urban	3.8	66.42
Rural	96.2	33.58
Religion		
Hindu	82.51	73.93
Muslim	14.74	18.64
Others	2.75	7.42
Caste		
Others	11.95	37.74
SC	28.44	12.96
ST	17.35	2.61
OBC	42.26	46.7
Birth Interval		
First birth order	36.07	48.69
< 24	27.61	14.19
> =24	36.32	37.12
State		
Andhra Pradesh	1.2	4.03
North East	3.6	1.1
Bihar	28.3	2.76
Chhattisgarh	3.8	2.49
Gujarat	1.1	9.61
Haryana	0.3	20
Jammu & Kashmir	0.3	1.13
Karnataka	5.9	0.8
Jharkhand	1.1	2.49
Madhya Pradesh	9.4	6.43
Maharashtra	1.8	8.26
Odisha	4.3	0.86
Rajasthan	4.2	7.15
Tamil Nadu	0.4	5.05
Uttar Pradesh	29.1	26.27
Uttarakhand	0.3	1.19
West Bengal	5.0	0.37
Total	3339	726

proportion of infant deaths for the first order births and for two or more order birth with greater than 24 months successive birth interval. However, for two or more order birth with less than 24 months successive birth interval poorest mother experience higher proportion of infant deaths than richest women. Among the bottom 20 percent poorest, Uttar Pradesh and Bihar accounts for more than 45 percent of the total infant deaths while for top 20 percent richest, Uttar Pradesh and Haryana accounts for nearly half of the total infant deaths.

Table 4 shows the concentration Index of inequality in infant deaths among various wealth index groups by selected background characteristics. Result shows that male infant deaths are more concentrated among poor male infants than female infant deaths and is statistically

Table 4
Concentration Index by various background characteristics, India, 2015-16.

Covariates	C.I	p-value
Child's Sex		
Male	-0.1494	0.0000
Female	-0.1260	0.0000
Mother's Age (at child's birth)		
15–19	-0.1684	0.0000
20–24	-0.1487	0.0000
25–29	-0.1320	0.0000
30–34	-0.1164	0.0000
35–39	-0.1262	0.0000
40–50	-0.0834	0.0006
Mother's Education		
No education	-0.0306	0.0004
Primary	-0.0448	0.0010
Secondary	-0.1276	0.0000
Higher	-0.1768	0.0000
Caste		
Scheduled Caste(SC)	-0.1257	0.0000
Scheduled Tribes (ST)	-0.0860	0.0000
Other Backward Caste (OBC)	-0.1448	0.0000
Other Castes	-0.1671	0.0000
Religion		
Hindu	-0.1472	0.0000
Muslim	-0.1162	0.0000
Others	-0.0697	0.0000
Place of Residence		
Urban	-0.1427	0.0000
Rural	-0.1135	0.0000
Birth Interval		
First birth order	-0.2205	0.0000
< 24	-0.0955	0.0000
> =24	-0.0852	0.0000
State		
Andhra Pradesh	-0.0992	0.0432
Arunachal Pradesh	-0.1242	0.0847
Assam	-0.1539	0.0000
Bihar	-0.0721	0.0000
Chhattisgarh	-0.1031	0.0001
Goa	-0.1786	0.4073
Gujarat	-0.1304	0.0004
Haryana	-0.1817	0.0000
Himachal Pradesh	-0.1537	0.0202
Jammu and Kashmir	-0.1637	0.0000
Jharkhand	-0.1331	0.0000
Karnataka	-0.2308	0.0000
Kerala	-0.2442	0.0393
Madhya Pradesh	-0.0834	0.0000
Maharashtra	-0.0890	0.0198
Manipur	-0.1640	0.0008
Meghalaya	-0.0471	0.3260
Mizoram	-0.0678	0.0899
Nagaland	-0.0775	0.1025
Delhi	-0.1670	0.0478
Odisha	-0.1441	0.0000
Punjab	-0.1173	0.0052
Rajasthan	-0.0945	0.0000
Sikkim	-0.2361	0.0204
Tamil Nadu	-0.1039	0.0116
Tripura	-0.2677	0.0022
Uttar Pradesh	-0.0731	0.0000
Uttarakhand	-0.1941	0.0000
West Bengal	-0.1277	0.0038
Telagana	-0.3841	0.0000

significant ($p < 0.01$).The infant deaths based on socio-economic group were concentrated among poor people for all age group mother but it was maximum for mother in the age group 15 to 19 years. The concentration of infant deaths among poor was maximum for mother who received higher education ($CI = -0.1768$ & $p < 0.01$) and found to be minimum among illiterate mothers ($CI = -0.0306$ & $p < 0.01$). Although all the groups had negative signs, the concentration of infant deaths among poor was higher in Hindus, OBC and OCs. Similarly, concentration of Infant deaths among poor was slightly higher in urban areas than rural areas. Concentration of infant deaths among poor was observed higher for first birth order child than children born in second or higher birth order. Infant deaths are concentrated more among poor in all the states of India. However, among all the states of India, Telangana has the maximum concentration of infant deaths among poor. It was followed by Tripura, Kerala, Sikkim and Karnataka. Minimum concentration of infant deaths among poor was observed in Meghalaya.

Table 5 shows the overall and detailed decomposition results for the factors contributed in inequality in propensity to experience infant deaths between bottom 20 percent poorest and top 20 percent richest. Result shows that differences in the propensity of infant deaths between poorest and richest due to effects (C) is higher than due to characteristics (E) change but both were found to be statistically significant ($p < 0.01$). The unexplained part contributed very small in increasing the inequality between the groups though it was statistically significant. A positive E_k coefficient indicates the expected reduction in propensity to experience infant deaths if bottom 20 percent poorest were equal to top 20 percent richest on independent factor X_k (like child's sex, mother's age at birth, mother's education, religion, caste, residence, birth interval and state of residence).Within differences in characteristics (E), results in 31 percent reduction in propensity to experience infant deaths between poorest and richest if women with no education will receive education till higher level. Similarly, there would be a 5 percent reduction in propensity to experience infant deaths between the two extreme wealth groups if women with primary education receive education till its reference group (i.e higher level). However, there would be a 10 percent increase in propensity to experience infant deaths between poorest and richest if women with secondary education reach to the level of women with higher education after controlling for other factors. These differences between wealth groups in propensity of infant deaths due to education was highly significant ($p < 0.01$). Women who gave birth to two or more children and have birth interval less than 24 months between these two successive births, would result in 5 percent reduction in the propensity of infant deaths between the two wealth groups if the distribution of these women was similar to women with more than two children and has successive birth interval 24 months or greater.

If we equalise the characteristics of states like Bihar, Chhattisgarh and Uttar Pradesh with its reference states that is Andhra Pradesh, these state will reduce the inequality in propensity to experience infant deaths between poorest and richest by 16 percent, 2 percent and 4 percent respectively. Within effect, if the change in the effect between Hindus and others religious groups among poorest is of same extent as that of the richest, the poorest-richest gap in propensity to experience infant deaths would be expected to increase by 5 percent. The first order birth contributed 26 percent in increasing the gap in propensity to experience infant deaths between poorest and richest in comparison to its reference group of birth order more than two and having birth interval less than 24 months. States like Gujarat and Maharashtra both contribute nearly 3 percent in increasing the inequality between poorest and richest in propensity to experience infant deaths in comparison to Andhra Pradesh and was statistically significant ($p < 0.1$).

5. Discussion

Health inequalities are differences in health between individuals or sub-groups of a population. Although inequalities are a measurement issues, equity is a normative concept of what is fair (Save the Children, 2013). Inequalities in health which are considered "unfair and avoidable" need to be addressed urgently. It is therefore not surprising that addressing inequalities in health generally and inequalities in child mortality more specifically are a major concern for national policy makers and international organisations.

Table 5
Logit decomposition result of contribution of various factors in leading to inequality in Infant deaths between bottom 20 percent poorest and top 20 percent richest population, India, 2015-16.

Covariates	Due to Difference in Characteristics (E)			Due to Difference in Coefficients (C)		
	Coefficient	SE	Percent contribution in total	Coefficient	SE	Percent contribution in total
Child's Sex						
Male						
Female	0.000058049	0.000	-0.21	0.002	0.002	-6.70
Mother's Age (at child's birth)						
15–19						
20–24	0.00047974	0.001	-1.70	0.001	0.005	-2.91
25–29	-0.00051885	0.001	1.84	0.002	0.009	-6.48
30–34	-0.00054926	0.001	1.95	0.001	0.005	-4.38
35–39	0.0000580	0.000	-0.21	0.000	0.003	-0.50
40–50	0.00012376	0.000	-0.44	0.000	0.001	1.60
Mother's Education						
Higher						
No education	-0.0088***	0.003	31.28	0.010	0.007	-36.76
Primary	-0.0015**	0.001	5.29	0.003	0.002	-8.95
Secondary	0.0028***	0.001	-9.93	0.003	0.002	-10.42
Religion						
Hindu						
Muslim	0.00014892	0.000	-0.53	0.0009	0.0006	-3.23
Others	0.00013102	0.000	-0.46	0.0014***	0.000553	-5.12
Caste						
Others						
SC	-0.00032162	0.000	1.14	0.00076331	0.00127	-2.71
ST	-0.00050669	0.001	1.80	0.0027904	0.002579	-9.90
OBC	9.5451E-06	0.000	-0.03	0.00074348	0.001556	-2.64
Place of Residence						
Urban						
Rural	-0.00016449	0.001	0.58	-0.007	0.005	23.60
Birth Interval						
> =24						
First birth order	0.0003106	0.001	-1.10	-0.0072***	0.001362	25.64
< 24	-0.00136***	0.000	4.82	-0.001617	0.00101	5.73
State						
Andhra Pradesh						
North East	-0.00047189	0.000	1.67	0.0020811	0.002001	-7.38
Bihar	-0.0046**	0.002	16.44	0.0077282	0.003969	-27.41
Chhattisgarh	-0.0005**	0.000	1.87	0.0013358	0.000924	-4.74
Gujarat	0.00045336	0.000	-1.61	0.00065**	0.000314	-2.30
Haryana	0.003176	0.002	-11.26	0.00014623	0.000102	-0.52
Jammu &Kashmir	0.00010394	0.000	-0.37	0.00028715	0.000297	-1.02
Karnataka	-0.00026724	0.001	0.95	0.0002816	0.00196	-1.00
Jharkhand	-0.00087935	0.001	3.12	-0.00026926	0.000185	0.95
Madhya Pradesh	-0.00073038	0.000	2.59	0.0027801	0.002204	-9.86
Maharashtra	0.00035369	0.000	-1.25	0.00074**	0.000354	-2.62
Odisha	-0.00034655	0.001	1.23	0.00058171	0.001416	-2.06
Rajasthan	0.00031236	0.000	-1.11	0.0014574	0.000917	-5.17
Tamil Nadu	0.000040681	0.000	-0.14	0.00011631	0.000109	-0.41
Uttar Pradesh	-0.0011***	0.000	3.80	0.0058434	0.003081	-20.72
Uttarakhand	0.00030597	0.0003	-1.09	-0.000026759	0.000104	0.09
West Bengal	0.00040334	0.0004	-1.43	-0.00061899	0.000908	2.20
Intercept				-0.050364	0.030516	178.62
N	**101487**					
Overall result						
Due to Difference in Characteristics (E)	-0.013***	0.0044781	47.481			
Due to Difference in Coefficients (C)	-0.015***	0.0047	52.519			
Raw	-0.028***	0.001				

Note:
** $p < 0.05$.
*** $p < 0.01$.

As expected during the 1990 liberalisation policy, number of states witnessed increased inequalities in child mortality across WI groups. Prior to adoption of liberalisation policy, there did exist social and economic inequalities in India. But liberalisation policy only worsened this situation (Save the Children, 2013). During 1990s increased inequalities was observed in number of states namely Assam,

Chhattisgarh, Gujarat, Maharashtra, Odisha, Rajasthan, and Uttar Pradesh. Number of other studies too have shown that socio-economic inequalities and regional disparities in infant and child mortality in India continue to persist and have increased over the years (Jain, Singh, & Pathak, 2013; Sen & Himanshu, 2004 Ghosh & Chandrasekhar, 2003; Pal & Ghosh, 2007; Ahluwalia, 2002).

However, in recent years, with number of new pro-poor policies, these inequalities have reduced and only few states like Odisha, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal reported rise in inequalities in infant and child mortality across WI groups. Contrary to the expectation that inequalities in child mortality were on the rise our analysis reveals that not only the gap between the poorest and richest WI groups has narrowed but also the magnitude of inequalities has declined in most states in India over recent years. The gains in infant and child mortality have been much more in lower socio-economic groups than in richer groups. However, inequalities between states and within states continue to persist and more work needs to be done in reducing inequalities further.

In addition, through the use of scatter plot, our study also helps identify the variation within the states among socio-economic groups that need to be targeted. Our study identified the worst performing states (e.g. Chhattisgarh, Odisha, Uttarakhand), both in terms of high mortality and high differentials between rich and poor. Other studies also support our findings in that large inequalities in child mortality were found in some of these states (Jain, Singh, & Pathak, 2013; Arokiasamy & Pradhan 2010; Joe, Mishra, & Navaneetham, 2010; Mohanty, 2011).

As inequalities in infant and child mortality are dynamic and evolving over time, our study makes a useful contribution in analysing this over 24 year period. Social gradient mentioned in other studies (Subramanian et al., 2008) is also observed in our study in that infant and child mortality is much higher among the poorest WI group as compared to those who belong to the richer category. Other studies too have concluded that poor child health is largely concentrated among poor households (Pradhan & Arokiasamy, 2010) and significant income gradient exists in infant mortality in India between 2000 and 2010 (Chalasani, 2012). A study on socio-economic inequalities in BRICS (Mújica et al., 2014) also confirms that both in 1990 and 2010, the greatest between-country differences in the rates of both infant and child mortality were those between India and the Russian Federation (Mújica et al., 2014). Similar to our results, other studies that report CI estimates also confirm considerable economic inequalities in maternal and child health indicators (Goli et al., 2013). Given that poor are at higher risk of various diseases, one would expect that utilisation of preventive services would be much more among poor. However, this is not the case in India (Victora et al., 2003).Those needing health care the most are least likely to get it (inverse health law) holds true in case of India (Balarajan, Selvaraj, & Subramanian, 2011).

Until recently, both at national and global levels, emphasis has been on infant and child mortality reductions at national/state levels with little concern about the distribution of these gains within the subgroups. Even the MDGs have been criticised for being insensitive to the equity concerns. Hence more recent approaches both at national and global level put emphasis on monitoring equity along with meeting necessary targets. For example, learning from the limitations of MDGs, monitoring equity is an important component of SDGs.

Emphasis on pro-poor strategies and attempts to reduce health inequalities is nothing new and has existed since long both at national and international level. For example, at the international level, WHO constitution and UN conventions affirms health as a fundamental human right. The Alma-Ata declaration and the WHO Primary Health Care approach (1978) were all geared to providing health for all and reducing inequalities. More recently, the WHO PHC report (2008a) and the WHO SDH Report (2008b) both renew attention towards reducing inequalities. In fact the SDH report makes a bold statement “Reducing inequalities is an ethical imperative- Inequalities are killing at a grand scale” (WHO, 2008b). Monitoring inequalities now along with meeting targets has become essential ingredient in various new global initiatives including SDGs.

Since independence, India has attempted to address socio-economic development and health inequalities by catering to needs of the poor through pro-poor policies. Right from Bhore Committee Report (1946) which focussed on covering rural population through SC, PHCs and CHCs to various five year national plans, Common Minimum Program (CMP) and even the National Health Policy documents over the years have continued to promote redistribution policies in order to reduce inequalities in general and in health care specifically by focussing on essential health care through primary care approach (Balarajan, Selvaraj, & Subramanian, 2011). Although the intent in these documents was good, the implementation of these measures was ineffective for number of reasons. Hence, the desired results were not observed. Subsequently, the 1990 liberalisation reforms in India further worsened the situation with respect to inequalities in health care.

GOI has launched various bold initiatives both at national and various state levels mainly targeting the poor families. National Rural Health Mission (NRHM) was launched in 2005 with the aim to reduce maternal and child mortality by strengthening the rural health system and promoting public private partnerships (NRHM Planning Commission, 2012). More recently, GOI is implementing various schemes for promoting institutional deliveries. Janani Suraksha Yojana (JSY) (Panja et al., 2012), Janani Shishu Suraksha Karyakram (JSK) and Pradhan Mantri Matrutva Vandan Yojana (PMMVY) have been recently launched. JSY and PMMVY provides incentives in the form of monetary (conditional cash transfer) whereas JSSK provides all services related to pregnancy and delivery free. In 2011, under the umbrella of NRHM, an additional component of neonatal /child care was added to existing JSY and called the scheme as Janani Shishu Suraksha Karykram (JSSK) (Gupta et al., 2012). Other newer schemes like the RMNCH + A strategy based on a continuum-of-care approach, Rashtriya Bal Swasthya Karyakram (RBSK) (PIB, GOI, 2013) etc. have also been introduced all with the aimed at reducing child and maternal mortality especially in lower socio-economic groups. In addition, to give a much needed boost to the health sector, GOI aims to increase the public health expenditure to 3% of its GDP (NRHM Planning Commission, 2012).

As health is a state subject, number of states are also introducing pro-poor schemes to reduce maternal and child mortality. For example, Bihar government launched Janani Evam Bal Suraksha Yojna in 2006 (GOI, 2007; CORT, 2008). It integrates the benefit of cash assistance with institutional care during delivery coupled with antenatal care and immediate post-partum care (GOI, 2007). Under this scheme, pregnant women from BPL (below poverty line) families receives Rs. 1400 in rural areas and Rs. 1000 in urban areas for registering with a clinic and giving birth either in a government or private hospital. All these recent initiatives have not only attempted to reduce child and maternal mortality overall but have also attempted to address inequalities by targeting these interventions to families below poverty line.

There are a number of policy implications from our study. It is important that policy makers target the underperforming states (upper outliers) as identified by the scatter plot in order to ensure reduction in variation between the states. These should fall down within the 95% CI. In addition, policy makers should focus on the larger states lying above CI on the right, namely the high impact states, as these represent the biggest population states with the potential for the most significant improvements in terms of reduction of IMR and U5MR. Our study also identifies the states which are not only underperforming in terms of high mortality but also have high differentials between the rich and the poor. Current policy in India is to focus on 18 states including eight empowered action group states (EAG) which are poor performing states with targeting of below poverty line families. Our study suggests a need for a more flexible approach to reducing child mortality among underperforming states. In fact, our findings can also be discussed in light of the aims of health policy i.e. Utilitarian vs. Rawlsian approach.

Utilitarianism would aim to provide greatest health to the greatest number and maximizes the aggregate health of the population whereas Rawls maximin principle would aim to maximise the health of those who have the least health. Policy makers in India can apply these aims of policy to the infant mortality context based on the findings of this paper. For example, those states that have high socio-economic differentials (e.g. Chhattisgarh, Odisha Uttarakhand) should benefit from Rawlsian approach i.e. selective targeting of child health interventions for lower socio-economic groups (pro-poor policies). On the other hand, states with high infant mortality like Madhya Pradesh, Uttar Pradesh, Bihar, Rajasthan, Jharkhand and Assam would benefit from Utilitarian approach that includes rapid scaling up of interventions that reduces the average level of infant and child mortality, irrespective of the socio-economic groups that may benefit from such reduction.

6. Conclusion

Across the world, literature abounds on inequalities in health between rich and poor. Although there is sufficient evidence of inequalities in child mortality, attempts to quantify such inequalities over time are limited. This paper therefore attempts to analyse temporal trends in inequalities in Indian states from 1992–2016. Our analysis confirms that India is moving in the right direction and the new initiatives introduced by the new Indian Government to reduce inequalities in infant and child mortality by reducing the gap between the socio-economic group seems to be working. However, in spite of India's achievements both in terms of high economic growth rates and reduction in infant and child mortality in recent years, it still has much work to do with respect to reducing inequalities. Depending upon a state's performance and the socio-economic differentials, policy makers may wish to be flexible in their approach in reducing infant and child mortality as discussed in this paper.

Ethical statement

None required as data in pubic domain.

Authors' contribution statement

All authors have contributed to the planning, writing and editing of this paper. All authors have seen and approved the final version of this manuscript.

Conflict of interest

None.

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