

Original Research Article

Inequalities in infant mortality rate in India from 1999-2020

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ABSTRACT

Background: Infant Mortality Rate is a key indicator of child survival and overall health system performance. Gender inequality in IMR, particularly in low and middle-income countries like India, reflects broader disparities in access to health care and societal preferences. The aim of this study is to assess the magnitude and trends of gender inequalities in infant mortality in India from 1999 to 2020.

Methods: This study utilized data from DHS and other related surveys, analysed through the WHO's health equity assessment toolkit (HEAT). IMR was disaggregated by gender and other equity stratifies (economic status, maternal age, place of residence and education). Inequality was assessed using simple (difference, ratio) and complex (population attributable risk [PAR], population attributable fraction [PAF]) measures.

Results: IMR remained consistently higher among males compared to females. However, the PAR and PAF values for gender inequality were consistently zero. Disparities were found across economic, educational, and residential dimensions. The poorest households, rural populations, mothers with no education, and younger mothers (15-19 years) exhibited higher IMR. Over time, these inequalities have declined but still remain significant, especially in wealth and education dimensions.

Conclusions: India has seen a decline in infant mortality over the past two decades, persistent inequalities - particularly along socio-economic and educational lines continue to challenge equity in child survival. Addressing these disparities requires targeted public health interventions and socio-economic reforms. The use of both simple and complex inequality metrics provides valuable insight for policymakers in prioritizing efforts towards more equitable health outcomes.

Keywords: Infant mortality, Gender inequalities, Economic disparities in health

INTRODUCTION

According to World Health Organization (WHO) Infant mortality rate (IMR) refers to the number of deaths of children under one year of age per 1000 live births. IMR is a probability of death derived from a life table and expressed as rate per 1000 live births.¹ Infant mortality includes neonatal mortality (the probability of dying within first 28 days of life) and post-neonatal mortality (the probability of dying between 28 days to 1 year of life). Infant mortality represents an important component of under-five mortality.¹ Like under-five mortality, IMR

also measure child survival. They also reflect the social, economic and environmental conditions in which children (and others in society) live, including their health care.¹ World IMR for 2020 was 28.50, a 1.38% decline from 2019.² According to NFHS 5 survey IMR and Neonatal mortality rate was 35 and 25 deaths per 1000 live births respectively and the IMR for male and female was 28.3 and 24.6 respectively.³

Gender is a multidimensional social construct, with distinct roles attributed to men and women in a specific society. Gender inequality is a social phenomenon in

which people are not treated equally based on their gender. Gender is hierarchical and produces inequalities that intersect with other social and economic inequalities.⁴ Gender inequality and discrimination faced by female puts their health and well-being at risk. Female often face greater barriers than male to accessing health information and services. These barriers include restrictions on mobility; lack of access to decision-making power; lower literacy rates; discriminatory attitudes of communities and healthcare providers; and lack of training and awareness amongst healthcare providers and health systems of the specific health needs and challenges of women and girls.⁴ Restrictive gender norms and inequalities influence the interaction within and between the health system.⁵ Sustainable Development Goals (SDGs) aim to optimize population health outcomes and minimize health inequalities. Goal 10 and Goal 5 states “Reduce inequality within and among countries” and “Achieve gender equality and empower all women and girls”.⁶ The natural advantage of survival of female child over males is lost in low-and-middle income countries (LMIC) where females are deprived of access to good nutrition and healthcare services.⁷ The main reason being preference for male child over females.

The IMR in India has declined from 79 during NFHS-1 (1992-1993) to 35 during NFHS-5 (2019-2021). The inequality in health concerns has recently attracted attention internationally with its clear mention as a development objective in global agenda, such as the SDGs. The most optimum method to decrease the inequalities to a manageable level is still unknown. Though few studies have assessed the IMR issue in India, there is a lack of studies addressing the magnitude and trends in inequalities in IMR. The WHO recommends the inequality to be measured using the absolute and relative measures for the selected health indicator to compare the disparities across the inequality dimensions. Hence, by using the WHO-recommended inequality measure can give proper evidence by comparing inequality stratified across the dimensions.

Therefore, this study aims at assessing the inequalities of IMR based on gender in India from 1999 to 2020.

METHODS

A study design and data source

A secondary data analysis was carried out using data from WHO Health Inequality Data Repository. The source of data was DHS program - DHS, ICEH - DHS, UNICEF - DHS, UNICEF - MICS, UNICEF - NSS, UNICEF - others. Data on infant mortality from years 1999 to 2020 were used to assess the trend in inequalities in terms of gender, economic status, place of residence, educational status and age of mother. The was conducted between May, 2025 to June, 2025.

Study variables

Infant mortality rate was the outcome variable for which inequality was measured. Infant mortality rate is defined as the total number of children under one years of age died per one thousand live births. The inequality is disaggregated by gender, economic status, place of residence, educational status and age of mother. Gender was classified in two groups i.e., male and female. The economic status was categorized into five quintiles as poorest (quintile 1), poorer (quintile 2), middle (quintile 3), richer (quintile 4), richest (quintile 5). Maternal age was classified into 2 groups i.e., 15-19 year and 20-49 year. Place of residence was classified into 2 groups i.e., rural and urban. Women were classified into 3 groups based on their educational status i.e., No education, primary education, secondary education.

Data analysis

Analyses were conducted using Health Equity Assessment Toolkit (HEAT) software (2024 update version 6.1, accessed on 16.05.2024) of the World Health Organization (WHO) using data from the reproductive, maternal, newborn, and child health datasets which was deposited in WHO Health Inequality Monitor. First, the infant mortality rate was disaggregated by equity dimensions. The disaggregation allowed us to present the distribution of estimates and confidence intervals of prevalence of infant mortality. Four inequality measures namely Difference, Population Attributable Risk (PAR), Population Attributable Fraction (PAF), Ratio were assessed and the measures are explained below which were described in detail in the technical notes of health equity assessment toolkit.

Difference is the simple and absolute measure of inequality calculated as the mean percentage of IMR in one group subtracted from the mean percentage of IMR in the other subgroup, whereas Ratio is the simplest and relative measure of inequality calculated as the percentage of IMR percentage in one subgroup to the mean percentage of IMR in the other subgroup.

Population attributable risk (PAR) is the absolute measure of inequality that shows how much the disparity is eliminated by decreasing the IMR in the population relative to the best performing subgroup, keeping the improvement rate constant as the reference subgroup. It is calculated as the difference between the estimate for the reference group and the setting average. The larger the absolute value of PAR means level of inequality is high. PAR is zero if there is no inequality.

Population attributable fraction (PAF) is a relative measure of inequality that takes into account the population size of all subgroups. It is calculated by dividing PAR by the setting average and multiplying the fraction by 100. There is a linear relationship between level of inequality and absolute value of PAF. PAF is

zero if there is no inequality and no further improvement is required in this aspect.

Ethical consideration

The study does not need any ethical clearance as the data were available publicly and uploaded as part of WHO HEAT software. The institution that conducted the survey completed all the necessary ethical procedure.

RESULTS

Distribution of infant mortality rate (IMR) among different subgroups

The trend of IMR among both the gender subpopulation from 1999 to 2020 in India was found to be higher among

male children than the female children. In 1999, IMR was higher by 3.7 per 1000 live births, 2 in 2006, 6.1 in 2015, and by 5.9 in 2020 among male children (Table 1). IMR was higher among the poorest (wealth quintile 1) group by 58.4 deaths per 1000 live births in 1999, 47.9 in 2006, 36.7 in 2015, and 29 in 2020 than among the richest (wealth quintile 5) population (Table 2). Among the 2-maternal age group population (15-19 and 20-49) IMR was found to be higher in 15-19 age group by 24 per 1000 live births in 1999, 25.3 in 2006, 13.3 in 2015 and 13.9 in 2020 than among 20-49 age group. IMR was also found to be higher in rural area than urban area. In rural area the IMR was higher by 30.5 per 1000 live births in 1999, 22.1 in 2006, 17.4 in 2015 and 12.1 in 2020 than urban area. IMR was also higher among the female with No education by 44.8 per 1000 live births in 1999, 35.1 in 2006, 22.5 in 2015 and 19.7 in 2020 than among the female with Secondary education.

Table 1: IMR as per gender, economic status, 2 maternal age groups, place of residence, education status of the mother from 1999 to 2020.

Dimensions	Years											
	1999	2006			2015			2020				
	Estimate	LB	UB	Estimate	LB	UB	Estimate	LB	UB	Estimate	LB	UB
Gender												
Female	71.1	68.3	73.7	63.9	60.9	66.9	39.1	38.1	39.9	32.6	31.6	33.4
Male	74.8	72.04	77.5	65.9	62.9	68.9	45.2	44.1	46.2	38.5	37.5	39.4
Wealth quintile												
Quintile 1	96.5	91.6	101.3	82.3	77.3	87.2	57.9	56.5	59.1	47.7	46.1	49.2
Quintile 2	80.7	76.3	85.09	73.2	68.3	78.1	48.5	46.8	50.2	41.5	39.9	43.01
Quintile 3	76.3	71.8	80.7	65.9	61.2	70.6	40	38.4	41.6	34.5	32.7	36.1
Quintile 4	55.3	51.3	59.2	51.3	47.1	55.4	30.9	29.1	32.7	27.2	25.3	29.1
Quintile 5	38.1	34.6	41.4	34.4	30.2	38.5	21.2	19.6	22.6	18.7	17.4	19.9
Age (2 groups)												
15-19 year	90.1	85.5	94.5	83.9	78.6	89.1	53.3	51.3	55.3	47.5	45.3	49.6
20-49 year	66.1	63.9	68.2	58.7	56.2	61.1	40	39.3	40.7	33.5	32.9	34.1
Place of residence												
Rural	79.7	76.8	82.4	70.6	67.8	73.3	47.2	46.2	48.1	39	38.2	39.6
Urban	49.2	45.6	52.7	48.5	44.7	52.1	29.8	28.5	31.06	26.9	25.5	28.2
Education												
No education	87	83.9	89.9	77.7	74.4	80.9	54.1	52.6	55.4	48.2	46.5	49.8
Primary	67	62.3	71.7	63.8	58.6	69.05	49.5	47.3	51.6	42.3	40.6	43.8
Secondary	42.1	39.2	45.02	42.6	39.6	45.5	31.5	30.5	32.5	28.5	27.7	29.2

Magnitude and trends in disparities in IMR

The poorest quintile, male children, 15-19 maternal age group population, female with No education and living in rural area had a higher prevalence of IMR over the years than richest quintile, female children, 20-49 maternal age group population, female with secondary education and living in urban area (Table 2).

This study also identified wealth-driven disparities in the IMR by both simple (difference and ratio) and complex

(PAR, PAF) measures, with a greater concentration among disadvantaged subpopulation, like the poorest population, compared to richest. For instance, the PAR and PAF measure -34.9 and -47.8 respectively in 1999, -30.6 and -47.1 respectively in 2006, -21.1 and -49.9 respectively in 2015, -16.9 and -47.5 respectively in 2020 indicated wealth related inequality with a higher prevalence on the poorest subpopulation (Table 2). Over the past 21 years, we observed no gender related inequalities in IMR as the PAR and PAF values are ZERO (Table 2).

Table 2: Gender, economic inequalities, 2 maternal age groups, place of residence, education of mother and IMR from 1999 to 2020.

Dimensions	Measure of inequality	Years			
		1999	2006	2015	2020
		Estimate	Estimate	Estimate	Estimate
Gender	Difference	-3.7	-2	-6.1	-5.9
	Ratio	1	1	0.9	0.8
	PAR	0	0	0	0
	PAF	0	0	0	0
Wealth quintile	Difference	58.4	47.9	36.7	29
	Ratio	2.5	2.4	2.7	2.5
	PAR	-34.9	-30.6	-21.1	-16.9
	PAF	-47.8	-47.1	-49.9	-47.5
Age (2 groups) 15-49year	Difference	24	25.3	13.3	13.9
	Ratio	1.4	1.4	1.3	1.4
	PAR	-6	-5.6	-2.1	-2.1
	PAF	-8.4	-8.8	-5	-6
Place of residence	Difference	30.5	22.1	17.4	12.1
	Ratio	1.6	1.5	1.6	1.4
	PAR	-23.8	-16.5	-12.5	-8.8
	PAF	-32.6	-25.4	-29.5	-24.6
Education	Difference	44.8	35.1	22.5	19.7
	Ratio	2.1	1.8	1.7	1.7
	PAR	-30.8	-22.2	-10.7	-7.1
	PAF	-42.2	-34.3	-25.3	-20

There are also age-related disparities in IMR for instance, PAR and PAF for 2 maternal age groups (15-19 year and 20-49 year) measure -6 and -8.4 respectively in 1999, -5.6 and -8.8 respectively in 2006, -2.1 and -5 respectively in 2015, -2.1 and -6 respectively in 2020 indicated a greater disadvantage among 15-19 years population (Table 2).

IMR also affected by the place of residence, for example inequality in IMR is higher among rural population, compared to urban population. For instance, the PAR and PAF measures are -23.8 and -32.6 respectively in 1999, -16.5 and -25.4 respectively in 2006, -12.5 and -29.5 respectively in 2015, -8.8 and -24.6 respectively in 2020 (Table 2).

This study also identified disparities in IMR based on educational status of the mother with a greater concentration among disadvantaged subpopulation, like mother with no education compared to mother with secondary education. The PAR and PAF measure -30.8 and -42.2 respectively in 1999, -22.2 and -34.3 respectively in 2006, -10.7 and -25.3 respectively in 2015, -7.1 and -20 respectively in 2020 indicated educational status related inequality with a higher prevalence on the population with no education (Table 2).

DISCUSSION

This study aimed to measure the magnitude and trend of inequality in mortalities among infants in India taking

data from DHS program from 1999 to 2020 using WHO HEAT toolkit. The infant mortality rate was higher among males and the poorest wealth quintile this period. However, infant mortality rate was decreasing consistently from 1999 to 2020. This study also found that inequalities in gender, economic dimensions, age of mother, place of residence and education of mother were decreasing over time. The inequality gap in relation to wealth quintile and education of mother is still very high.

The infant mortality rate has also been decreasing globally, from 55 to 29 between 1999-2020.⁸ However, most of these deaths in 2020 were occurring in African countries such as Sierra Leone, Central African Republic, Somalia and Nigeria.⁹

In a study conducted by Aghai ZH et al stillbirths and early neonatal mortality rate was significantly higher in male infants but no significant difference in late neonatal mortality.¹⁰

Mukhopadhyay J in his study found that risk of mortality was high among male infants. Also birth order more than 4 with spacing less than 2 years and maternal age of 35 yrs and above were significantly associated with infant mortality. Socioeconomic and environmental factors contributed significantly towards the gender difference in infant mortality.¹¹

In a study by Chowdhury R et al they found the odds of mortality in female infants is higher compared to males across all sociodemographic and economic strata.¹²

Zegeye B et al found higher IMR among infants in poorest households, rural residents, mothers who had no formal education and had male infants.¹³

In a study by Osborne A et al in Sierra Leone, they found that IMR dropped from 111.1 in 2008 to 77.4 in 2019. Also, inequalities across various dimensions such as gender of child, age of mother, economic status and maternal education also fell substantially. However, inequality in terms of residence i.e., rural/urban increased from 7.4 to 13.8. The PAF and risk were zero indicating female and male children had equivalent mortality rates.¹⁴

Shibre G found that children born to poor and uneducated women living in rural areas were at a significantly higher risk. Also, males were at a higher risk of death than females.¹⁵

Bhatia M et al in their study found over 50% decrease in IMR from NFHS- 1 to NFHS- 4. However, states like Uttar Pradesh, Bihar and Madhya Pradesh have consistently underperformed. Also, Female infants and women with short birth spacing had higher risk of infant deaths in poor performing states.¹⁶

In India, prematurity, low birth weight, pneumonia, birth asphyxia, birth trauma, congenital anomalies are the leading causes of infant mortality.¹⁷ However, the decrease in infant mortality in India may be attributable to implementation of various health programs like skilled birth attendance, Janani Suraksha Yojana, RMNCAH+N, IMNCI, Janani Shishu Suraksha Karyakaram etc.

CONCLUSION

In our study, the trend and magnitude of inequalities in infant mortality rate in India have been measured based on gender, economic status, age of mother, place of residence and education of mother dimensions from 1999-2020 using data from DHS program. Infant mortality in India is declining since 2000. However, the inequalities in wealth and education remains a problem.

The use of both simple and complex measures to determine the inequality in the above-mentioned dimensions makes the result more informative for decision maker. We used the analytical technique recommended by WHO which strengthens the quality of the study.

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