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Long-term Trends and Rural-Urban Differential in Birth, Death and Infant Mortality rates in Haryana, India

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Abstract

Haryana is a high income, rapidly urbanizing state of north India that has a long experience of strong son preference. There is some evidence in the long run of the changes in its birth, death and infant mortality rates, and any narrowing of the rural-urban mortality gap. The objective of the study is to determine the long-term trend, structural change and rural-urban differentials in the crude birth rate (CBR), crude death rate (CDR) and infant mortality rate (IMR) of Haryana during 1971-2023. Fourteen Sample Registration System (SRS) observations (1971, 1980, 1990, 2000, 2010, 2015-2023) for rural, urban and combined populations were analyzed using log-linear regression (annual percent change APC), compound annual growth rates (CAGR), one-join point regression with a permutation test, Mann-Kendall and Sen's slope for 2015-2023, paired t test and Wilcoxon test for rural–urban differences, trend test on absolute and relative gaps, a baseline-trend estimate of pandemic-period excess mortality, and a Kitagawa decomposition of the change in CBR. Results: The combined CBR fell from 42.1 to 18.7 per 1,000 (-55.6%; APC -1.56%, 95% CI -1.61 to -1.51) and the combined IMR from 72 to 26 per 1,000 (-63.9%; APC -2.57%). The IMR declined slowly before 2000 (-0.63% a year), and increased at a rate of -4.49% a year after 2000 (join point 2000, permutation $p = 0.002$). The rural-urban gap in birth rate narrowed from 11.8 to 3.2 per 1,000, but the relative IMR gap widened from 1.21 in 2000 to 1.45 in 2023 (rural 29 vs urban 20). Mean rural excess over urban was 4.61 (CBR), 1.66 (CDR) and 13.89 (IMR) per 1,000 (all paired tests $p < 0.01$). In 2021 the CDR was 2.44 per 1,000 (42%) above the 2015–2019 trend, and the urban excess (3.10) exceeded the rural (1.92). Decline in the CBR between 1971 and 2023 was more attributable to the decline in rural and urban areas than to the process of urbanization. Found that, Haryana had undergone demographic transition in the least in 50 years, but the situation of urban-rural equity in infant survival is worsening in relative terms, and that infant mortality during the pandemic did not keep up the trend to 2023.

Keywords: birth rate; death rate; infant mortality; rural–urban differentials; Haryana

1.Introduction

The demographic transition is at very different stages across the states of India (Dandona et al., 2017). As a new state on its own since 1966, Haryana exhibits high growth rates in the National Capital Region (NCR) and social indicators of concern such as son preference which

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manifest in a male sex ratio at birth (SRB) (Bhat and Zavier, 2003; Jha et al., 2006). Its urbanization rate has increased consistently over time and urbanization typically is associated with declining birth and death rates (Dyson, 2011).

The SRS is a data source maintained by Registrar General of India which provides annual vital rates by rural-urban residence. Long series are available in various state tables, like in the Statistical Abstract of Haryana, but these are seldom analyzed using formal trend and break-point and decomposition methods. As a result, three questions remain unanswered for Haryana: (i) when did the pace of decline change; (ii) are rural-urban gaps converging in absolute and in relative terms; and (iii) how much of the aggregate decline is due to behavior change within sectors as opposed to urbanization itself.

1.1 Demographic Transition and urbanization

The classical transition theory (Thompson, 1929) has also been revisited in the light of global evidence: for the first time, Lee (2003) demonstrates the global three-century drop in the mortality rate, followed by fertility drops, and Bongaarts (2008) describes the irregularity and some stalls in fertility drops in developing countries. Dyson (2011) suggests that urbanization is a consequence of and a driver of the transition and that a lot of urbanizations in developing countries comes from natural increase.

1.2 Fertility change in India and north India

Using the 2011 Census, Guilmoto and Rajan (2013) estimated the spatial variation of the fertility transition across Indian districts, which showed significant district-level variation once more. Bhat and Zavier (2003) used the fall in fertility in northern India to link a stronger gender bias to a fall in fertility; Das Gupta et al. (2003) placed son preference in a broader context of East and South Asian countries; and Jha et al. (2006) found that second births in India become more likely to be male when the first child is a girl.

1.3 Infant and child mortality

Arokiasamy (2004) reported the regional variations in sex bias and excess female child mortality in India. Arokiasamy and Gautam (2008) analyzed neonatal mortality in the Empowered Action Group states and Kumar, Singh and Rai (2012) conducted a study on under-five mortality at the district level in high focus states. The Millennium Death Study (Million Death Study Collaborators, 2010) was the national study that identified the primary causes of neonatal and child mortality and the Global Burden of Disease subnational estimates (India State-Level Disease Burden Initiative Child Mortality Collaborators, 2020) provided the national estimates of neonatal and under-five mortality trends between 2000 and 2017. Global child mortality rates have been declining steadily since the 1990s (Rajaratnam et al., 2010) and neonatal death rates represent a significant proportion of infant deaths, which is decreasing slowly (Lawn et al., 2005).

1.4 Rural-urban differentials

The proximate-determinants framework is the most widely used prism for understanding child survival (Mosley and Chen, 1984). In India, Saikia et al (2013) has studied the socio-economic

differences in infant mortality rate between rural and urban areas and found that significant portion of the rural–urban difference in infant mortality rate in India could be explained by differences in socio-economic and maternal characteristics, whereas Mohanty and Pathak (2009) documented a consistent socioeconomic gradient in the utilization of the RCH services in India. Rural-urban differences in service use are thus a likely explanation for the rural–urban difference in infant mortality.

1.5 Mortality in the pandemic periods

In the years 2020-21, Wang et al. (2022) calculated the global excess mortality and ranked India among countries showing the highest absolute increase in mortality, and Jha et al. (2022) assessed the actual COVID-19 mortality in India based on survey data and deaths recorded in health facilities, finding that actual mortality was well higher than the official numbers. They conclude that state-level vital rates for 2021 are subject to interpretation in the context of the pre-pandemic trend.

1.5 Research Gap

Most of the reviewed studies reported on here are national or multi-state level studies that focus on a single outcome or on sex bias alone. No application of join point and non-parametric trend and decomposition methods to the entire rural-urban SRS series for Haryana from 1971-2023 was found, nor any that poses the question of whether the rural-urban inequality of infant mortality rates is closing or widening. The present paper fills this gap.

2. Study Area

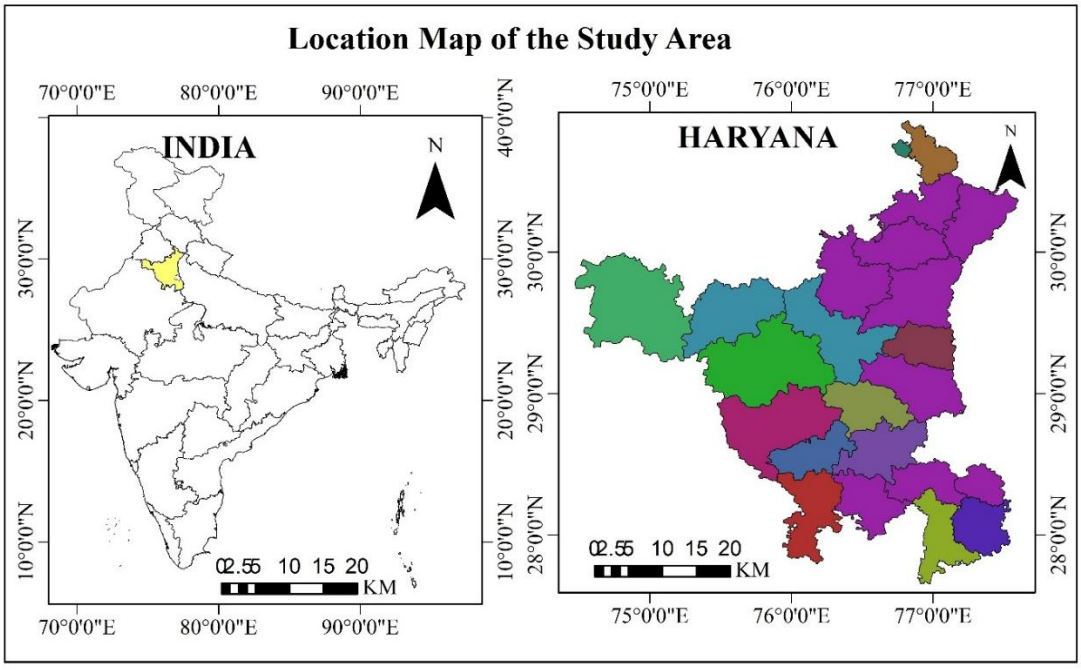


Fig. 1: Location map

Haryana is situated in north west India and is surrounded by the city of Delhi from three sides (about 44,212 km²) (Figure 1). About 14 of its 22 districts are part of the Haryana sub-region of the NCR, the region where the state has experienced the fastest urbanisation, and 12 of these

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districts are already urbanized. The state has experienced its highest urbanisation rates in the Haryana sub-region of the NCR, of which 14 of its 22 districts already have urban populations. The analysis in this paper is carried out at state level, by rural or urban residence and the study area shown in Figure 1 is showing the location of the study area which is not used to depict any outcome variable, as the rates shown in the SRS table are not available at district level.

3. Data and Methodology

The data on rural, urban and combined CBR, CDR and IMR for year 1971, 1980, 1990, 2000, 2010, 2015-2023 are available in the table 3.1. There are 14 time points (decadal to 2010, annual from 2015) in the series. No values in the table for 2011–2014 were imputed.

Table 3.1: Acquired data

Year	CBR R	CBR U	CBR C	CDR R	CDR U	CDR C	IMR R	IMR U	IMR C
1971	44.2	32.4	42.1	10.4	7.3	9.9	74.0	58.0	72.0
1980	38.3	31.4	37.2	12.0	7.2	11.2	112.2	52.8	103.5
1990	33.1	27.5	31.9	8.9	6.9	8.4	73.0	53.0	69.0
2000	27.9	23.0	26.9	7.9	6.2	7.5	69.0	57.0	67.0
2010	23.3	19.8	22.3	7.0	5.6	6.6	51.0	38.0	48.0
2015	22.3	18.4	20.9	6.3	5.7	6.1	39.0	30.0	36.0
2016	22.0	18.3	20.7	6.3	5.1	5.9	35.0	27.0	33.0
2017	21.9	18.2	20.5	6.3	5.0	5.8	32.0	25.0	30.0
2018	21.7	18.0	20.3	6.6	4.9	5.9	33.0	25.0	30.0
2019	21.4	17.9	20.1	6.6	4.8	5.9	30.0	23.0	27.0
2020	21.2	17.7	19.9	6.5	5.5	6.1	31.0	23.0	28.0
2021	20.8	17.4	19.5	8.7	7.4	8.2	30.0	22.0	27.0
2022	20.6	17.4	19.3	7.6	6.9	7.3	30.0	20.0	26.0
2023	20.0	16.8	18.7	7.1	6.4	6.8	29.0	20.0	26.0

R=Rural, U=Urban, C=Combined. IMR is infant deaths per 1,000 live births. *(Source: Department of Health Services, Haryana)*

3.2 Statistical Methods

All computations are performed using the NumPy, SciPy and stats models' libraries of Python 3 and all tests are performed at the two-tailed 0.05 significance level.

(i) Log-linear trend" and "Percent change per year:

For each series,

$$1n(y_t) = \alpha + \beta t + \varepsilon_t \qquad (1)$$

It was fitted by OLS (t = year-971).

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Annual percent change

$$APC = 100\left(e^{\beta} - 1\right) \quad (2)$$

and 95% confidence limits are obtained by transforming the 95% confidence limits of β. The model is exponential decay, suitable for rates that are decreasing towards a floor.

(b) The compound annual growth rate: for 1971–2000, 2000–2023 and 1971–2023.

$$CAGR = 100\left[\left(\frac{y_{end}}{y_{start}}\right)^{\frac{1}{t_{end}-t_{start}}} - 1\right] \quad (3)$$

Relative change

$$RC = 100\left(\frac{y_{end}}{y_{start}} - 1\right) \quad (4)$$

(c) Joinpoint regression: A continuous one-knot piecewise log-linear model:

$$\ln(y_t) = \alpha + \beta_1 t + \beta_2 (t - \tau)_+ + \varepsilon_t \quad (5)$$

It was fitted for τ in {1990, 2000, 2010, 2015, 2016, 2017, 2018}, which guarantees at least three observations in the first segment. A permutation test (2,000 permutations of the residuals of the linear model, with the knot search repeated under each of these permutations) was conducted to see if the knot minimizing the residual sum of squares is better than the linear model, after Kim et al. (2000).

Segment APCs are:

$$APC_1 = 100\left(e^{\beta_1} - 1\right) \quad (6)$$

$$APC_2 = 100\left(e^{\beta_1+\beta_2} - 1\right) \quad (7)$$

(d) Non-parametric trend: 2015–2023. For the nine consecutive annual points, the Mann–Kendall test (Mann, 1945; Kendall, 1975) with Kendall's τ and Sen's slope (Sen, 1968) with 95% confidence limits was used. The statistic is:

$$S = \sum_{i<j\backslash} operatornamesgn\left(y_j - y_i\right) \quad (8)$$

$$\tau = \frac{S}{n(n-1)/2} \quad (9)$$

There is no reliable autocorrelation correction available (Hamed and Rao, 1998; Yue et al., 2002) for this short series because of ties.

(e) Rural–urban differences. The differences between the annual values for each indicator

$$d_t = R_t - U_t \quad (10)$$

(dt = Rt − Ut) were assessed using the paired t-test and Wilcoxon signed-rank test (Wilcoxon, 1945). Effect size is (Cohen, 1988):

$$d_z = \frac{\bar{d}}{s_d} \quad (11)$$

Time was plotted as the absolute gap (R − U) and relative gap (R / U) using OLS and Spearman's ρ with year respectively.

(f) Natural increase and vital index-(Preston, Heuveline and Guillot, 2001).

$$NIR = CBR - CDR \qquad (12)$$

$$VI = 100 \times \frac{CBR}{CDR} \qquad (13)$$

(g) Excess mortality during the pandemic. A linear model of CDR on year was fitted to 2015–2019 (n = 5) and extrapolated to 2020–2023. Excess = observed – predicted with 95% prediction interval (PI). Any observations made outside the PI were considered to be above the baseline.

(h) Kitagawa decomposition (Kitagawa, 1955). The rate is a combination of C = wU + (1 − w) R, where the combination weight is w, the urban weight. This weight as indicated by the published rates (C − R)/ (U − R) was used (which exactly reproduces C). Between two dates,

$$\Delta C = \Delta U \frac{w_0+w_1}{2} + \Delta R \frac{(1-w_0)+(1-w_1)}{2} + \Delta w \left[\frac{U_0+U_1}{2} - \frac{R_0+R_1}{2}\right] \qquad (14)$$

The first two are the rate effect within urban and the rate effect within rural areas, respectively, and the final is urbanisation (composition effect). Only CBR was decomposed, the CDR rural-urban gap is too small for stable implied weights and IMR is weighted by the number of births not by population.

4. Results

4.1 Overall trends

The combined rates of the three all decreased (Table 4.1 and 4.2, Figure 2 and Figure 3). The CBR fell from 42.1 (1971) to 18.7 (2023), a relative fall of 55.6%; the CDR from 9.9 to 6.8 (-31.3%); the IMR from 72 to 26 (-63.9%). The natural increase rate fell from 32.2 to 11.9 per 1,000 (rural 33.8 to 12.9; urban 25.1 to 10.4), and the combined vital index from 425 to 275, with a minimum of 238 in 2021.

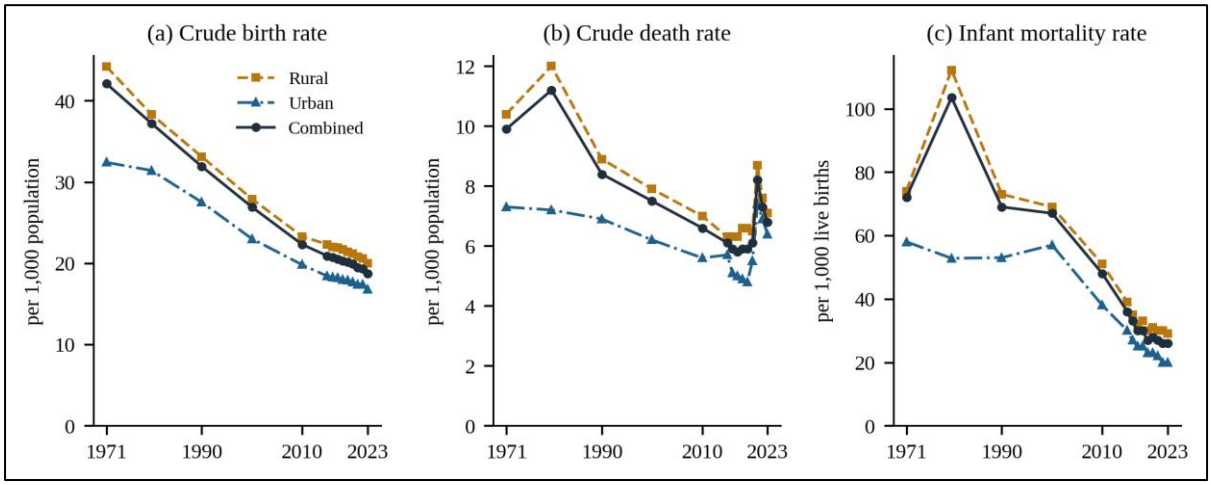


Fig.2: Trends in (a) crude birth rate, (b) crude death rate and (c) infant mortality rate

Table 4.1 Log-linear annual percent change, 1971–2023 (n = 14)

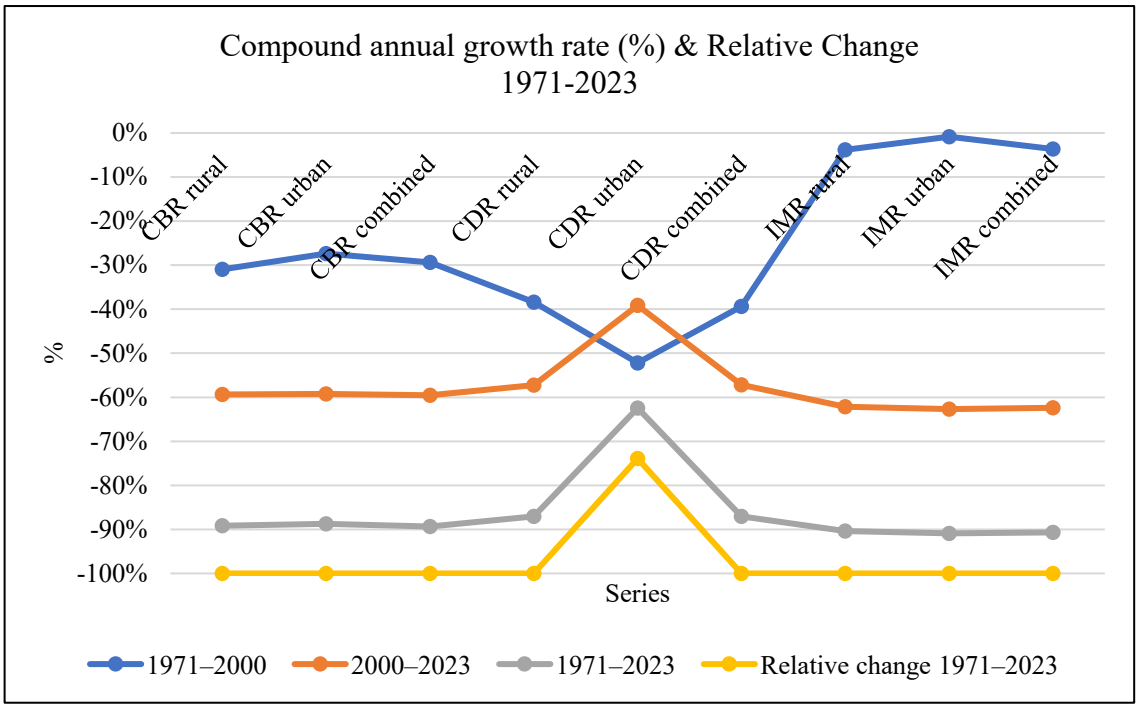
Series	APC (%)	95% CI	R^2
CBR rural	-1.50	-1.55 to -1.44	0.996
CBR urban	-1.34	-1.43 to -1.26	0.989
CBR combined	-1.56	-1.61 to -1.51	0.998
CDR rural	-0.98	-1.41 to -0.55	0.670
CDR urban	-0.50	-1.00 to 0.00	0.283 (p = 0.050)
CDR combined	-1.00	-1.45 to -0.55	0.658
IMR rural	-2.44	-3.04 to -1.83	0.863
IMR urban	-2.19	-2.80 to -1.59	0.836
IMR combined	-2.57	-3.18 to -1.94	0.869

For CBR and IMR all $p < 0.001$, for rural and combined CDR the urban CDR trend is borderline ($p = 0.050$), showing an increase during the pandemic period. The CBR declined almost in a perfect exponential fashion ($R^2 \geq 0.989$) while the IMR and CDR were more irregular.

Table 4.2: Compound annual growth rate (%) and relative change 1971-2023

Series	1971–2000	2000–2023	1971–2023	Relative change 1971–2023
CBR rural	-1.57	-1.44	-1.51	-54.8%
CBR urban	-1.17	-1.36	-1.26	-48.1%
CBR combined	-1.53	-1.57	-1.55	-55.6%
CDR rural	-0.94	-0.46	-0.73	-31.7%
CDR urban	-0.56	+0.14	-0.25	-12.3%
CDR combined	-0.95	-0.43	-0.72	-31.3%
IMR rural	-0.24	-3.70	-1.79	-60.8%
IMR urban	-0.06	-4.45	-2.03	-65.5%
IMR combined	-0.25	-4.03	-1.94	63.9%

Fig.3: Compound annual growth rate (%) and relative change



The decline in birth-rate was consistent during both periods while IMR virtually remained unchanged during 1971-2000 (-0.25% a year) and decreased more than sixteen times as fast thereafter (-4.03%). Urban IMR was 58 in 1971 and 57 in 2000 (53 in 1990), so the whole pre-2000 gain was about one point.

4.2 Structural breaks

Let's look at IMR for rural, urban and combined populations and see that this has fallen significantly since 2000 (Table 4.3), with a rate of around -4.2 to -4.5% per year since 2000 (Figure 4). The levels of urban IMR remained unchanged at the pre-break level (+0.07%). No significant break was found for combined and urban CBR, but the decline was slowed for CBR after 2010 (-1.60 to -1.16 a year). The increase in CDR in 2018 is due to the pandemic in 2021, and should not be seen as a structural shift in the CDR of ordinary deaths.

Table 4.3: One-joint point regression results

Series	Joinpoint	APC before	APC after	Permutation p
IMR combined	2000	-0.63	-4.49	0.002
IMR rural	2000	-0.70	-4.17	0.019
IMR urban	2000	+0.07	-4.43	< 0.001
CBR rural	2010	-1.60	-1.16	0.002
CBR combined	2015	-1.60	-1.24	0.095
CBR urban	1990	-1.03	-1.46	0.118
CDR combined	2018	-1.33	+5.02	0.010

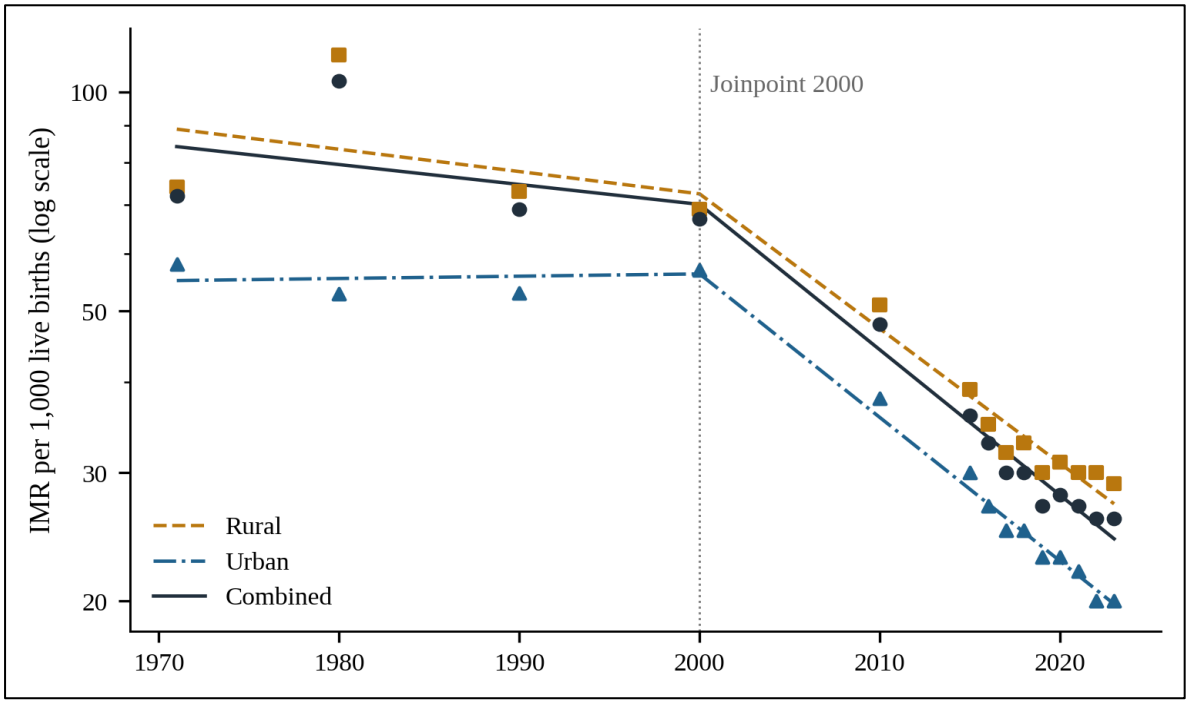


Fig. 4: Observed infant mortality rate (points) and fitted one-join point log-linear model

4.3 Recent Trends

There was a steady decrease in births and a steady increase in infant deaths, of approximately 0.23 births and 1 infant death per 1,000 per year respectively. The CDR went up, notably in rural areas ($\tau = 0.65$), due to the post-2020 growth (Table 4.4).

Table 4.4. Mann–Kendall test and Sen's slope, 2015–2023 (n = 9)

Series	Kendall's τ	p	Sen's slope per year (95% CI)
CBR rural	-1.000	< 0.001	-0.255 (-0.300 to -0.200)
CBR urban	-0.986	< 0.001	-0.163 (-0.214 to -0.140)
CBR combined	-1.000	< 0.001	-0.233 (-0.300 to -0.200)
CDR rural	0.648	0.019	+0.120 (0.000 to 0.300)
CDR urban	0.222	0.477	+0.179 (-0.100 to 0.460)
CDR combined	0.471	0.087	+0.114 (0.000 to 0.350)
IMR rural	-0.841	0.002	-1.000 (-1.500 to -0.500)
IMR urban	-0.957	< 0.001	-1.000 (-1.429 to -1.000)
IMR combined	-0.899	0.001	-1.000 (-1.500 to -0.667)

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4.4 Rural-urban differential

Table 4.5: Paired comparison of rural and urban rates

Indicator	Mean R − U	SD	t	p (paired t)	p (Wilcoxon)	d_z
CBR	4.61	2.32	7.42	< 0.001	< 0.001	1.98
CDR	1.66	1.11	5.61	< 0.001	< 0.001	1.50
IMR	13.89	13.63	3.81	0.002	< 0.001	1.02

The effect sizes are large ($dz \geq 1.0$) and the rural rates are higher than urban rates for each of the 14 years for all three indicators (Table 4.5). The test assumes that the differences between the years are independent but they are not (serial dependence) and therefore gives indicative p-values; the Wilcoxon results are consistent.

Table 4.6: Selected absolute and relative gaps (rural minus urban; ratio)

Year	CBR gap	CBR ratio	CDR gap	IMR gap	IMR ratio
1971	11.8	1.36	3.1	16.0	1.28
1980	6.9	1.22	4.8	59.4	2.12
2000	4.9	1.21	1.7	12.0	1.21
2010	3.5	1.18	1.4	13.0	1.34
2015	3.9	1.21	0.6	9.0	1.30
2019	3.5	1.20	1.8	7.0	1.30
2022	3.2	1.18	0.7	10.0	1.50
2023	3.2	1.19	0.7	9.0	1.45

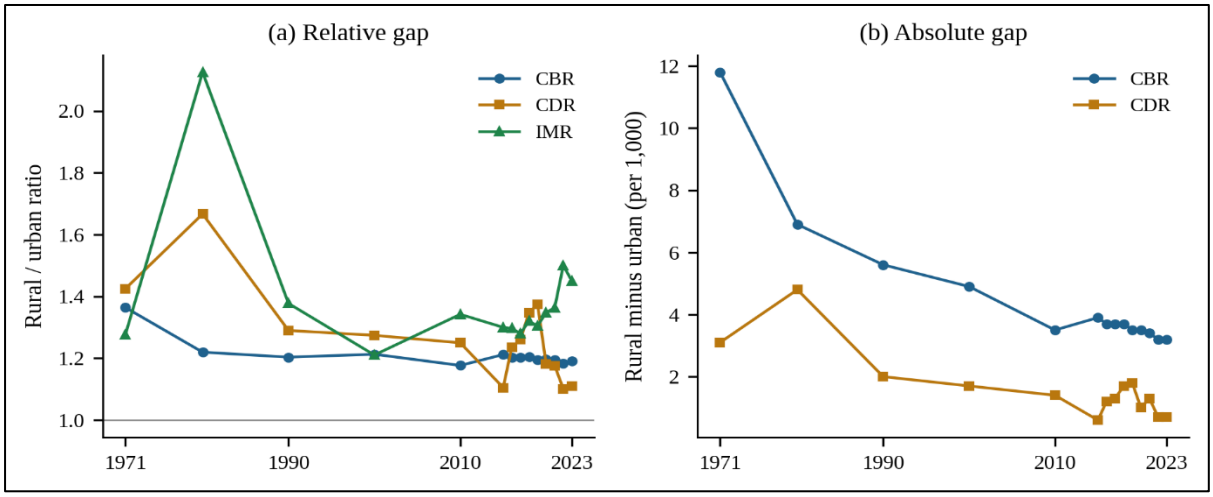


Figure: 5: Rural–urban gaps (a) relative gap (b) absolute gap

The absolute gaps declined significantly (Table 4.6, Figure 5): CBR -0.126 per year ($p < 0.001$), CDR -0.055 ($p < 0.001$) and IMR -0.543 ($p = 0.009$). The relative CBR gap also declined (Spearman $\rho = -0.73$, $p = 0.003$), as did the relative CDR gap ($\rho = -0.66$, $p = 0.010$). In contrast, the relative IMR gap showed no significant monotonic trend ($\rho = +0.35$, $p = 0.21$) but rose from 1.30 in 2015 to 1.45 in 2023 after reaching 1.50 in 2022. The absolute gap between the IMRs is very high in 1980 (59.4, rural 112.2) reaching its peak in the long-run slope. Overall, CBR and CDR, to a lesser extent for IMR: the absolute gap has reduced owing to both rates declining, and infants in urban areas have improved relative growth after 2015.

4.5 Pandemic-period mortality

The future values of Combined CDR in the years 2021, 2022 and 2023 lie outside the prediction interval but not in the year 2020 (Table 4.7, Figure 6), which substantiates for the former years. By 2023 the rural CDR is back at trend, and the urban CDR (6.4) is significantly higher than the extrapolated baseline (3.9). The urban excess is perhaps exaggerated (since a falling series with a linear extrapolation of five points is an optimistic guess), but the trend is the same in all three years.

Table 4.7: Observed CDR versus the 2015–2019 linear baseline (per 1,000)

Year	Combined: observed / expected (95% PI)	Excess (%)	Rural excess (%)	Urban excess (%)
2020	6.1 / 5.80 (5.32-6.28)	+0.30 (+5%)	-0.19 (-3%)	+1.00 (+22%)
2021	8.2 / 5.76 (5.21-6.31)	+2.44 (+42%)	+1.92 (+28%)	+3.10 (+72%)
2022	7.3 / 5.72 (5.09-6.35)	+1.58 (+28%)	+0.73 (+11%)	+2.80 (+68%)
2023	6.8 / 5.68 (4.96-6.40)	+1.12 (+20%)	+0.14 (+2%)	+2.50 (+64%)

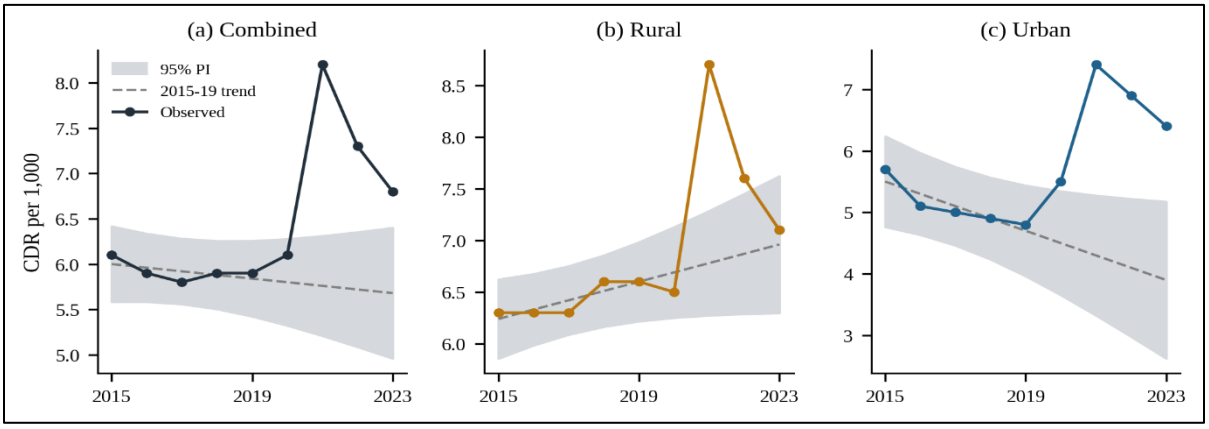


Fig. 6: Observed crude death rate, 2015–2023, against the linear trend fitted to 2015-2019 (dashed) with its 95% prediction interval (shaded): (a) combined; (b) rural; (c) urban.

4.6 Decomposition of the fall in CBR

The urban weight implied by the published rates rose from 0.178 (1971) to 0.406 (2023).

Table 4.8: Kitagawa decomposition of change in combined CBR (per 1,000)

Period	Total change	Within urban	Within rural	Composition (urbanisation)	Composition share
1971–2023	−23.40	−4.56	−17.13	−1.71	7.3%
1971–2000	−15.20	−1.80	−13.19	−0.22	1.4%
2000–2023	−8.20	−1.89	−5.49	−0.82	10.0%
2010–2023	−3.60	−1.04	−2.16	−0.40	11.2%

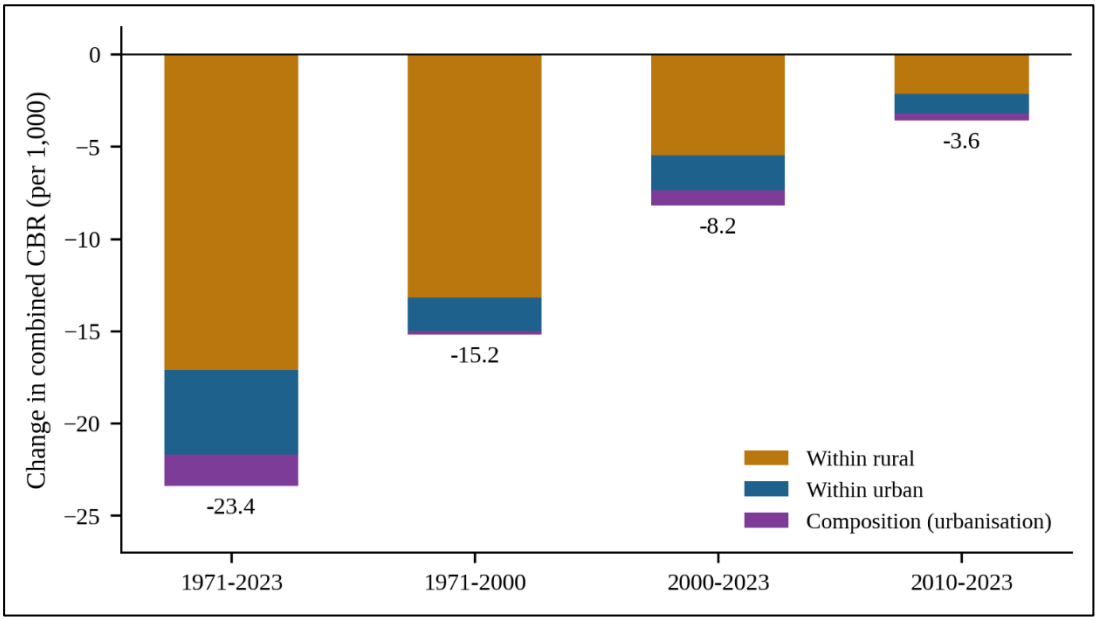


Fig. 7: Kitagawa decomposition of the change in the combined crude birth

Support has declined, 92.7% of which is within sector (Table 4.8, Figure 7) and 73.2% of which is rural. Pre 2000, the proportion of urbanization is 1.4% and it increases to approximately 10-11% post 2000. Note that a robustness caution; the implied weights are not the same as Census urban shares in some years (e.g. 2000, 0.204 vs. about 29% Census 2001); this is likely due to different weighting used for combined rates in the SRS. The implied-weight sensitivity calculation, using approximate Census urban shares (about 17.7% in 1971 and 34.9% in 2011) yields a composition effect of about -1.3 per 1,000 for 1971-2010, roughly the same as the implied-weight result and the substantive conclusion is not materially altered.

5. Discussion

The rural CBR experienced a greater decline, by over onehalf, at almost constant exponential rate, compared to the urban CBR (-1.50% vs. -1.34% annually). As a result, the rural–urban gap shrank from 11.8 to 3.2 per 1,000. This is similar to the diffusion of low fertility from towns to villages found in the district level studies (Guilmoto and Rajan, 2001, 2013) and to

the perspective that aggregate decline is not necessarily attributable to urbanization per se but to behavioral change within sectors (Dyson, 2011). This is supported by the decomposition, as over 90% of the decrease was in rural and urban areas. The rural decline after 2010 was slow (join point, $p = 0.002$) and is likely to be part of a transition that has a later stage. The presence of a greater gender bias in Haryana in association with lower fertility, as hypothesized by Bhat and Zavier (2003) and Jha et al. (2006) for northern India, cannot be tested here, as the data used lacks sex specific rates.

The most significant result is the drop in 2000 with little change in infant survival rates prior to that and a decline of approximately 4.5% per annum following that year among all residence groups. This happens at the same time as Rajaratnam et al. (2010) saw the rate of child mortality reductions pick up around the world, and during the national and state health programmers of the 2000s, although this time analysis can make no claim to which specific programme caused this rate change. However, this neonatal component has proven to be the largest and least declining component of infant mortality as per the findings of Lawn et al. 2005, and the Million Death Study 2010, which may account for the Sen's slope remaining at approximately one death per 1,000 per year since 2015.

While absolute gaps decreased for all indicators, the relative IMR gap increased to 1.45 in 2023, which suggests an increased advantage for urban infants. Thus, the rural–urban disparities in India are found to be based on socioeconomic and maternal factors as noted by Saikia et al. (2013), and also noted by Mohanty and Pathak (2009) is that the different patterns of utilization of child health services exist between rural and urban areas. For policy purposes, relative gaps are more significant than absolute gaps, as a narrowing absolute gap may be associated with a dramatic deterioration in the relative situation of infants living in rural areas. “Caution is warranted” because IMR is a small-sample SRS estimate rounded to whole numbers which will move the ratio by 0.05 or more when changing by 1 point.

The urban excess of the CDR for 2021 was 42% higher than the 2015-2019 trend and the rural excess was larger than the urban excess, consistent with evidence from the national level that the number of COVID-19 deaths was significantly under-reported (Jha et al., 2022; Wang et al., 2022). The combined CDR continues to be above the prediction interval in 2023, which could indicate a continued recovery or an optimistic starting point.

Policy implications. (i) The relative rural–urban gaps should be monitored in addition to the absolute rural–urban gaps. (ii) Attention should be given to improving the delivery and neonatal care services in rural areas. (iii) Standard errors of SRS estimates should be published by state health information systems. (iv) Capturing post-pandemic vital statistics should be compared to pre-2020 trend baselines.

6. Limitations

(1) There are only 14 time points, irregularly spaced, and missing data between 2011-2014; the trend tests assume independent errors. (2) SRS estimates are sample-based, rounded to 1 decimal (rounded to whole numbers for IMR) and there is no standard error reported in the table. The data are ecological and there are no covariates (education, income, health service use), hence the analysis is descriptive but not explanatory. (3) Trends in gap are affected by the

1980 rural IMR (112.2), which is an outlier. (4) The excess mortality baseline for urban areas is a five-point extrapolation. This is because the definition of a rural area is different for each Census.

Conclusions

The overall birth rate in Haryana has declined by 55.6%, death rate has declined by 31.3% and infant mortality rate has declined by 63.9% between 1971-2023. The decline of births was fairly constant, and occurred almost exclusively in rural and urban areas, while the decline of infant mortality was negligible until 2000 and then increased at approximately 4.5% per year. Rural rates are still higher than urban rates and the absolute differences are actually decreasing, however the relative difference is increasing and has grown to 1.45 in infant mortality. The mortality rates in 2021-2023 were also above the pre-pandemic trend, particularly in urban areas. Future research should examine these patterns using district level SRS or Census data with covariates, sex-specific rates and cause of death information, and provide thematic maps of districts.

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Data Source- The source data are publicly available (Statistical Abstract of Haryana)

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