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Descriptive Finding

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Ashish Kumar Upadhyay

Kaushalendra Kumar

Abhishek Singh

Nikos Tzavidis

Ashish Singh

Sabu S. Padmadas

Fiifi Amoako Johnson

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Ashish Kumar Upadhyay[1]
Abhishek Singh[2]
Ashish Singh[3]
Fiifi Amoako Johnson[4]
Kaushalendra Kumar[5]
Nikos Tzavidis[6]
Sabu S. Padmadas[7]

Abstract

BACKGROUND
Despite widespread interest in son preference in India, the study of its spatial distribution and trends by parity at the district level is limited.

OBJECTIVE
This study investigates spatial patterns and temporal trends in son preference by parity across districts of India from 2002 to 2021.

METHODS
We applied model-based area-level small area estimation techniques on data from consecutive rounds of the Indian National Family Health Survey and the District Level Household Survey to derive district-level estimates of son preference by parity. Spatial

[1] Research scientist, GENDER Project, International Institute for Population Sciences, Mumbai, India. Email: ashu100789@gmail.com. ORCID ID: 0000-0003-2518-4603.
[2] Corresponding author. Department of Public Health & Mortality Studies, International Institute for Population Sciences, Mumbai, India. Email: abhishek@iipsindia.ac.in. ORCID ID: 0000-0001-6263-4410.
[3] Shailesh J. Mehta School of Management, IIT Bombay, Mumbai, India. Email: singhmb.ashish@gmail.com. ORCID ID: 0000-0002-7385-5363.
[4] Department of Population and Health, Faculty of Social Sciences, University of Cape Coast, Ghana. Email: famoakojohnson@ucc.edu.gh. ORCID ID: 0000-0003-0896-937X.
[5] Department of Public Health & Mortality Studies, International Institute for Population Sciences; member of the Centre of Demography of Gender, International Institute for Population Sciences, Mumbai, India. Email: kaushal@iipsindia.ac.in. ORCID ID: 0000-0001-5913-0297.
[6] Department of Social Statistics and Demography and Southampton Statistical Sciences Research Institute, University of Southampton, United Kingdom. Email: n.tzavidis@soton.ac.uk. ORCID ID: 0000-0002-8413-8095.
[7] Department of Social Statistics and Demography and Southampton Statistical Sciences Research Institute, University of Southampton, United Kingdom. Email: S.Padmadas@soton.ac.uk. ORCID ID: 0000-0002-6538-9374.

patterns and clustering were examined using Moran's I and local indicators of spatial autocorrelation across multiple rounds of survey.

RESULTS
At parity 1, only a few districts showed a strong son preference in 2002–2004, but this number steadily increased in each subsequent survey round. In contrast, the number of districts with high son preference at parity 2 rose in 2007–2008 and then declined in subsequent rounds. At parity 3 or higher, the number of districts showing a strong son preference declined consistently in each subsequent survey round.

CONCLUSIONS
Son preference in India exhibits distinct spatial and evolving temporal patterns across parities. The increasing prevalence at parity 1 and declining trends at higher parities suggest shifting reproductive behaviours. These findings underscore the need for targeted district-level, parity-specific interventions to address persistent and emerging gender-biased norms in son preference.

CONTRIBUTION
This study is the first of its kind to examine trends in son preference by parity across Indian districts in the last two decades using data from four consecutive rounds of large-scale national household surveys conducted between 2002 and 2021.

1. Introduction

India's deeply rooted son preference, driven by economic, social, religious, and familial norms, has significant social, economic, and demographic impacts across regions and states (Alkema et al. 2014; Chao et al. 2020; Chaudhuri 2012; Diamond-Smith and Bishai 2015; Echavarri and Ezcurra 2010; Guilmoto et al. 2018; Guo, Das Gupta, and Li 2016; Kashyap 2019; Kashyap and Villavicencio 2016; Kashyap and Behrman 2020; Patel et al. 2013; Robitaille and Chatterjee 2018; Saikia et al. 2021; Singh, Gaurav, and Das 2013). However, there is a paucity of research analysing temporal changes in son preference at the district level, where significant heterogeneity is frequently obscured by state-level aggregates (Singh et al. 2022).

Son preference remains a critical policy challenge in India as it perpetuates gender-biased practices such as sex-selective abortion, unequal resource allocation, and lower investment in girls' health and education, undermining gender equity goals. Despite declining fertility rates and socioeconomic progress, deeply entrenched cultural norms continue to reinforce son preference across both urban and rural settings, leading to skewed sex ratios and long-term demographic imbalances.

Selecting the right indicator is therefore crucial for studying son preference trends by parity across Indian districts. Common measures such as sex ratio at birth, child sex ratio, under-5 mortality differentials, sex-selective abortion, and ideal number of sons have limitations such as under-reporting and social desirability bias. In contrast, the desire for an additional child among families with only daughters, versus those with a son, is easier to report on and subject to less bias (Singh et al. 2022; Vanneman, Desai, and Vikram 2012). We consider this indicator to examine district-level son preference trends.

The Indian National Family Health Survey (NFHS) and District Level Household Survey (DLHS) provide key data on son preference nationally and at the state level. However, small district-level sample sizes cause high sampling variability, making direct survey estimates unreliable (Pfeffermann 2002; Rao and Molina 2015). Small area estimation (SAE) is used to produce reliable estimates for small geographies or subpopulations, effectively addressing the challenges posed by small sample sizes. SAE integrates survey data with census data or administrative records, improving the accuracy of estimates without increasing sample size. Singh et al. (2022) applied area-level SAE to produce reliable district-level estimates of son preference in India, which would otherwise be difficult to obtain due to small sample sizes. Building on their work, we extend the application of SAE methods to produce reliable district-level estimates of son preference by parity over time, thereby introducing a temporal dimension to the analysis.

Understanding district-level variations is essential for informing precise evidence-based policy interventions that address localised variations in son preference, thereby strengthening the effectiveness of efforts to promote gender equity amidst India's rapid socioeconomic transformation.

2. Data and methods

2.1 Data

We used data from DLHS-2 (2002–2004), DLHS-3 (2007–2008), NFHS-4 (2015–2016), and NFHS-5 (2019–2021) to estimate district-level son preference by parity across India. Both surveys employed a two-stage stratified sampling design: Villages and census enumeration blocks were selected in the first stage using probability proportional to size, followed by systematic sampling of households. Both surveys were conducted by the International Institute for Population Sciences (IIPS), Mumbai.

DLHS-2 surveyed 620,107 households and 507,622 currently married women aged 15–44, with an 87% response rate. DLHS-3 covered 720,320 households and 643,944 ever-married women aged 15–49, excluding Nagaland, with an 89% response rate.

NFHS-4 and NFHS-5 interviewed 601,509 and 636,699 households, respectively, and 699,686 and 724,115 ever-married women aged 15–49, respectively, both with a 97% response rate. DLHS used the 2001 census as the sampling frame, while NFHS used the 2011 census.

Model-based SAE methods leverage auxiliary data to produce robust local-level estimates. In this study, district-level auxiliary variables were sourced from the 2001 and 2011 Indian censuses. Variables from the 2001 census were used for estimates corresponding to DLHS-2 and DLHS-3, while those for NFHS-4 and NFHS-5 were based on the 2011 census. The 2001 and 2011 censuses reported 593 and 640 districts, respectively. Son preference estimates were generated for 593 districts in DLHS-2, 585 districts in DLHS-3,[8] and 640 districts in both NFHS-4 and NFHS-5. While NFHS-5 surveyed 707 districts, bifurcated districts were merged with their parent districts to produce estimates for 640 districts, aligning with the availability of auxiliary data from the 2011 census.

2.2 Outcome variable

Following Singh et al. (2022), we estimated the percentage of non-pregnant women not desiring an additional child among (1) those with at least one son and (2) those without a son, by parity (1, 2, and 3 or higher) for each district. The difference between these groups served as our outcome variable, an indicator of son preference. Positive values indicate son preference, with higher values reflecting stronger preference. Conversely, negative values suggest no preference for sons in the district. As DLHS-2 collected fertility preference data only from non-pregnant women, we restricted our analysis to non-pregnant women across all survey rounds for consistency.

2.3 Methods

Since the sample size in many districts was insufficient to produce reliable direct estimates of son preference by parity, we applied the Fay–Herriot (FH) area-level SAE method (Fay and Herriot 1979; Pfeffermann and Di Maio 2021). This approach was used to estimate the percentage of non-pregnant women not desiring an additional child among (1) those with at least one son and (2) those without a son, by parity (1, 2, and 3 or higher) for each district. The FH model links direct survey estimates with census-based auxiliary

[8] Eight districts from the state of Nagaland could not be surveyed in DLHS-3 for reasons not known. While the fitted model could be used to generate estimates for the non-surveyed districts, we did not consider the option since the estimates for the non-surveyed districts might be different from those for the surveyed districts.

variables, which include women's education, the literacy gap, urban residence, workforce participation, fertility rate, female population share (aged 15–49), caste, religion, and state fixed effects.

We used the *svydesign* function in R to compute direct estimates and smoothed their variances using an OLS model (Chen et al. 2022). SAE models were made using the EMDI package (Kreutzmann et al. 2019), with direct estimates serving as the key input. Diagnostics included bias checks, coefficients of variation (CVs), 95% confidence intervals (CIs), mean squared errors (MSEs), and Q-Q plots to assess model validity and reliability. For a detailed description of the methods and diagnostics, see Singh et al. (2022).

District-level estimates of son preference by parity (1, 2, and 3 or higher) were spatially mapped, and spatial clustering was assessed using Moran's I and local indicators of spatial autocorrelation (LISA) in GeoDa to identify spatial patterns that can inform targeted policy interventions. LISA identifies districts with different spatial patterns of high son preference by comparing each district's value to those of its neighbours. It shows districts with high son preference surrounded by other high-preference districts (high-high) and districts with low son preference surrounded by other low-preference districts (low-low); these are considered spatial clusters. It also identifies districts with high son preference neighbouring districts with low son preference (high-low) and districts with low son preference neighbouring high-preference districts (low-high); these are classified as spatial outliers (Anselin 1995).

3. Results

The analysis of district-level residuals, including Q-Q plots and histograms, confirmed the normality assumption of the SAE model, with residuals randomly distributed and fitting expected patterns (not shown separately; available from the authors on request). Model-based estimates demonstrated stronger precision and consistency compared to direct survey-based estimates, showing tighter clustering around the mean and smaller CVs (not shown separately; available from the authors on request) and CIs (Figure 1). Overall, the diagnostics indicate that the model-based SAE estimates of son preference are reliable, efficient, and consistent with design-unbiased survey data while meeting model assumptions.

Figure 1: Comparison of 95% CIs for direct survey-based and model-based estimates, India, 2002–2021

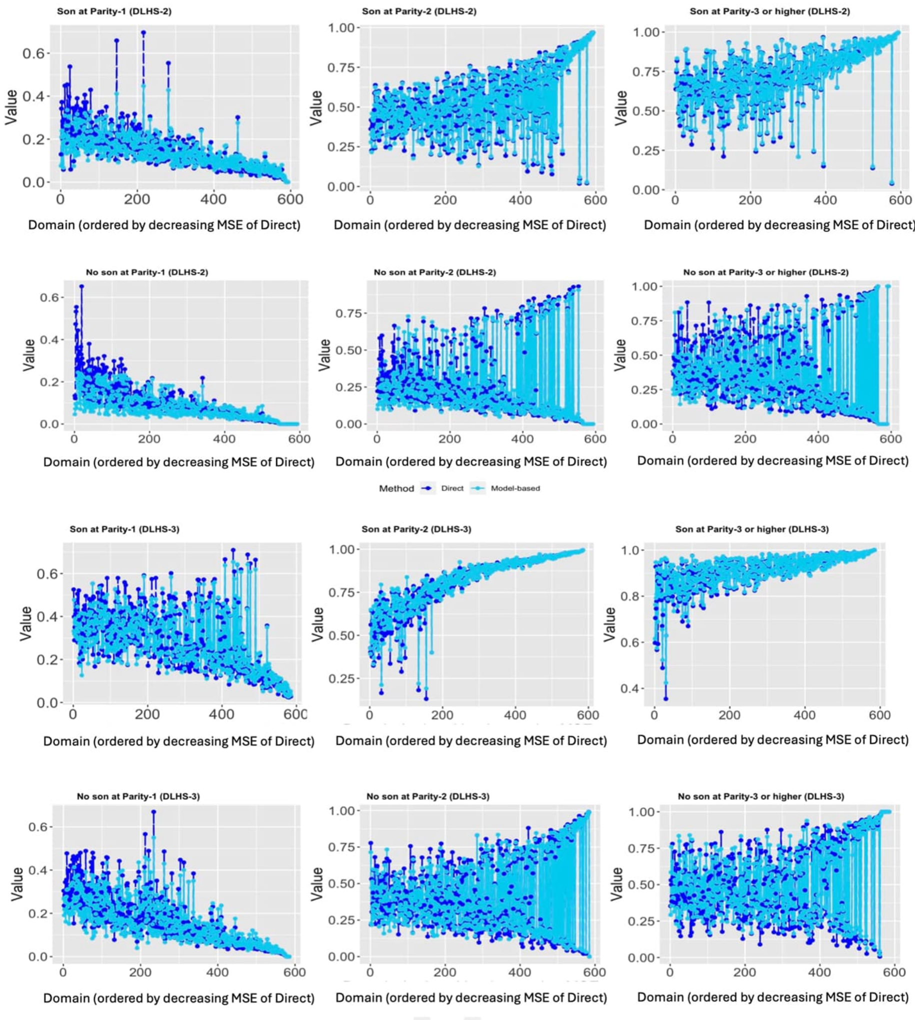
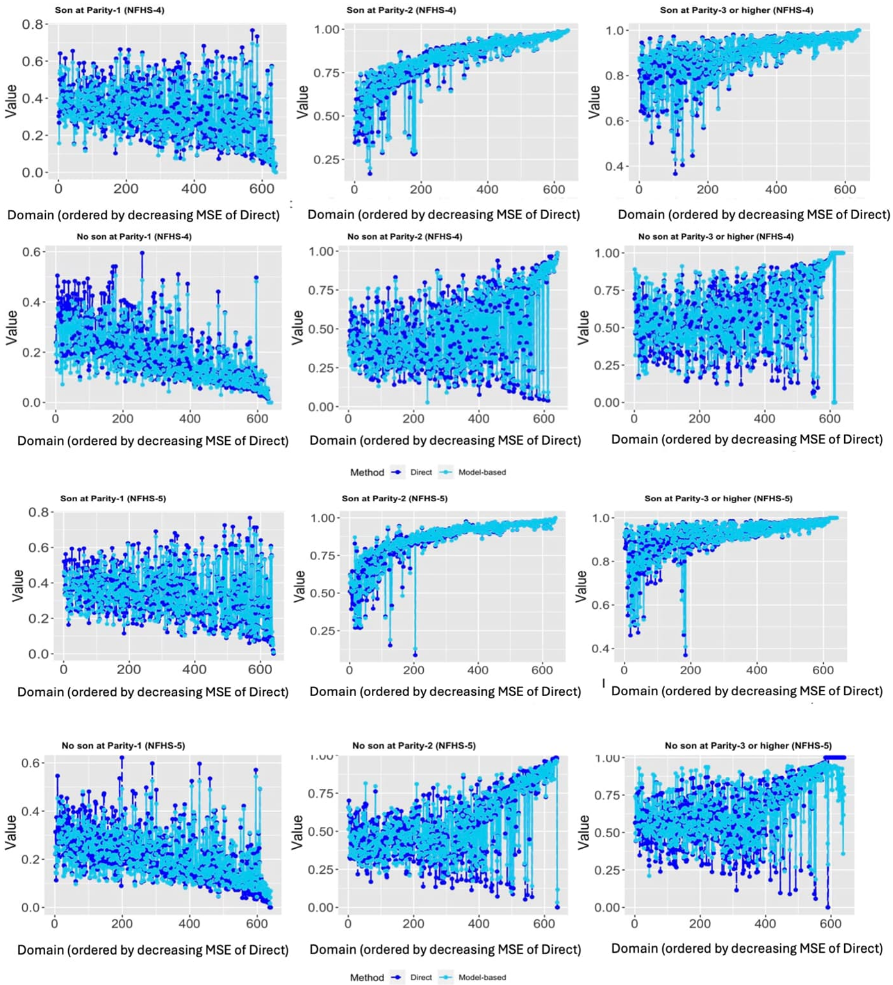


Figure 1: (Continued)



At parity 1, the average district-level difference between women with a son who did not desire more children and those without a son who did not desire more children was 5.1% in 2002–2004 (Table 1). This difference steadily increased over time, reaching 10.6% in 2007–2008, 11.6% in 2015–2016, and 12.1% in 2019–2021. In contrast, at parity 2, the average difference rose from 29.9% in 2002–2004 to 35.8% in 2007–2008 but then declined to 31.6% in 2015–2016 and declined further, to 29.5%, in 2019–2021.

For parity 3 or higher, the average difference was 39.2% in 2002–2004 and consistently declined in subsequent periods – to 36.8% in 2007–2008, 28.0% in 2015–2016, and 25.0% in 2019–2021.

Table 1: Average district-level percentage of women who do not desire additional children, categorized by parity and presence of a son, across survey years in India, along with differences between those with and without a son

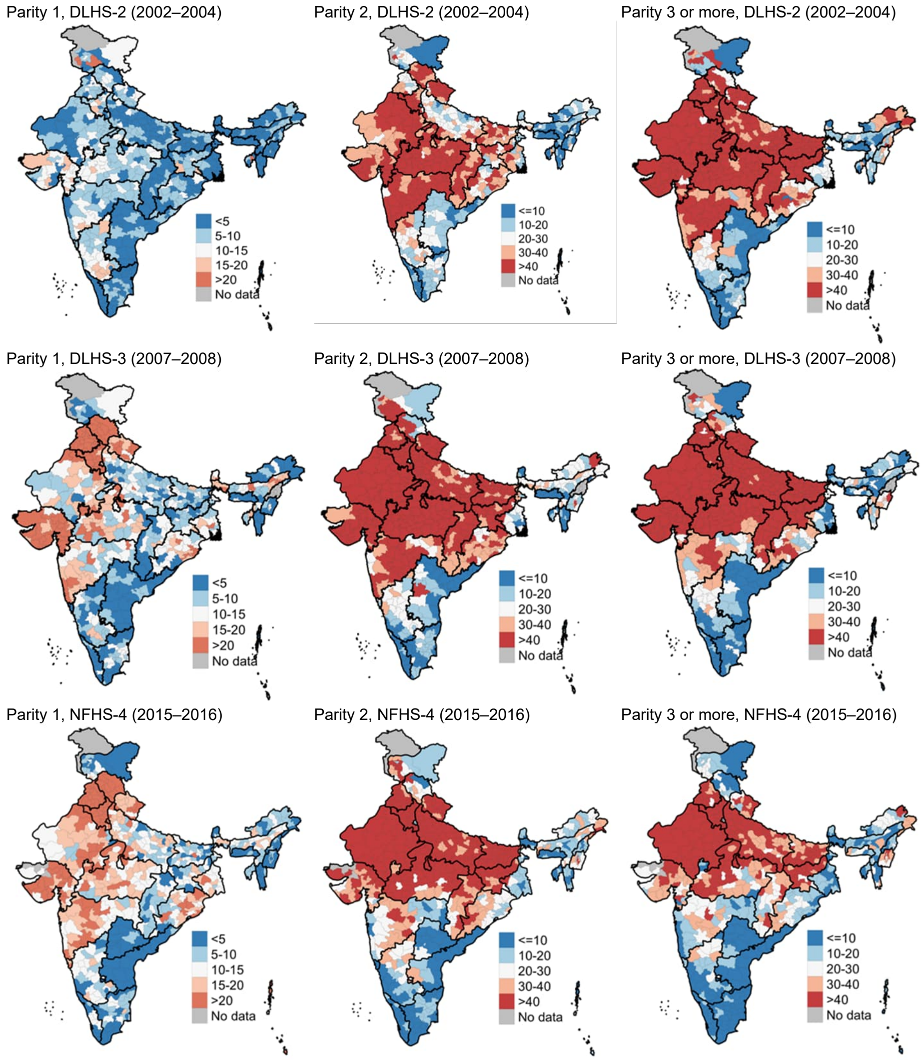
	Parity 1			Parity 2			Parity 3 or more		
	Son	No son	Difference	Son	No son	Difference	Son	No son	Difference
DLHS-2 (2002-04)	12.5	7.4	5.1	52.4	22.5	29.9	71.4	32.1	39.2
DLHS-3 (2007-08)	31.1	20.5	10.6	81.1	45.2	35.8	91.3	54.5	36.8
NFHS-4 (2015-16)	34.5	22.9	11.6	82.4	50.8	31.6	89.4	61.4	28.0
NFHS-5 (2019-21)	35.9	23.8	12.1	85.5	56.0	29.5	92.2	67.2	25.0

Figure 2 shows the estimates of the son preference across Indian districts for the period between 2002 and 2021. At parity 1, the difference between women with and without a son who did not want another child ranged from –7.2% (Kargil, Ladakh) to 31.9% (Punch, Jammu, and Kashmir) in 2002–2004, from –10.8% (Karimnagar, Andhra Pradesh) to 50.2% (Mahendragarh, Punjab) in 2007–2008, from –11.0% (Karikal, Puducherry) to 58.3% (Faridkot, Punjab) in 2015–2016, and from –11.1% (South Andaman) to 46.4% (Jind, Haryana) in 2019–2021. Districts with son preference above the national average increased steadily: 360 (2002–2004), 463 (2007–2008), and 522 (2019–2021).

At parity 2, the highest son preference was in Mahendragarh (75.8%) in 2002–2004, in Jind (92.9% in 2007–2008; 78.7% in 2015–2016), and in Dausa (72.5%) in 2019–2021. Lowest estimates were in East Garo Hills (1.0% in 2002–2004), Thiruvananthapuram (0.2% in 2007–2008), East Khasi Hills (0.04% in 2015–2016), and West Khasi Hills (0.01% in 2019–2021). Districts above the 2002–2004 national average (24.5%) rose from 368 to 420 in 2007–2008 and then declined to 413 (2015–2016) and 385 (2019–2021).

At parity 3 or higher, son preference peaked in Morena (83.9% in 2002–2004), Sonipat (89.4% in 2007–2008), Gurgaon (96.1% in 2015–2016), and Sawai Madhopur (74.8% in 2019–2021), with the lowest in Leh (2002–2004, 2019–2021), West Kameng (2007–2008), and Erode (2015–2016). Districts above the 2002–2004 average (31.9%) fell from 358 to 250 in 2019–2021.

Figure 2: Model-based estimates of son preference by parity, India, 2002–2021



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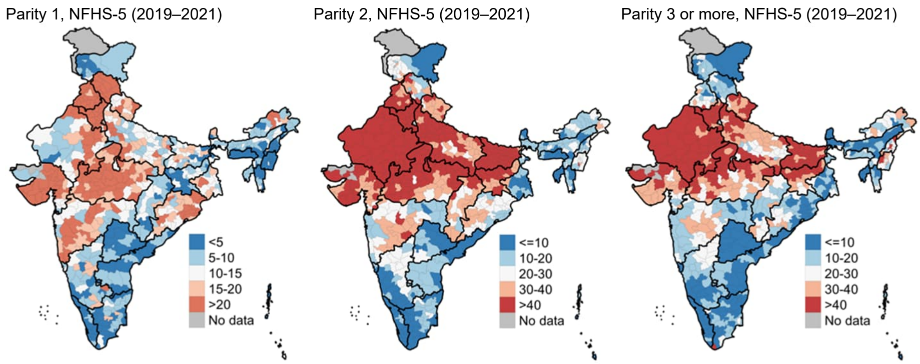


Moran's I values are shown in Table 2. Moran's I exceeded 0.6 for all parities and years, except parity 1 in 2002–2004, indicating strong spatial clustering of son preference across Indian districts over time.

Table 2: Moran's I values for estimates of son preference by parity, India, 2002–2021

Son preference at different parities	DLHS-2 (2002–2004)	DLHS-3 (2007–2008)	NFHS-4 (2015–2016)	NFHS-5 (2019–2021)
Difference in the percentage of women of parity 1 not desiring an additional child among women with a son and women without a son	0.333	0.691	0.725	0.710
Difference in the percentage of women of parity 2 not desiring an additional child among women with at least one son and women without a son	0.711	0.807	0.811	0.829
Difference in the percentage of women of parity 3 or higher not desiring an additional child among women with at least one son and women without a son	0.742	0.828	0.756	0.753

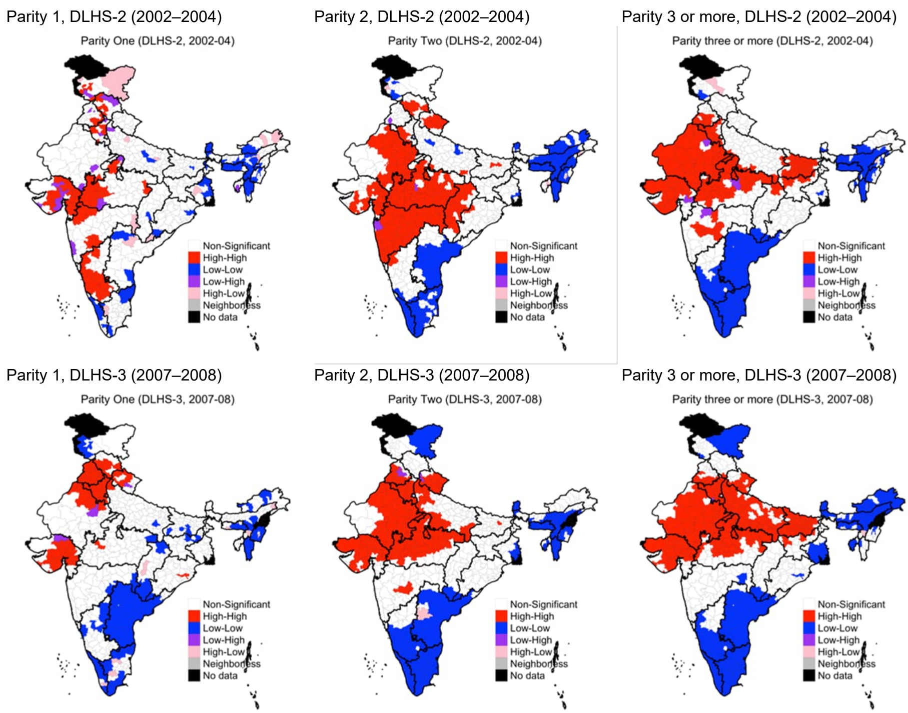
Figure 3 shows the LISA map for son preference by parity for the period 2002–2021. Between 2002 and 2021, spatial clustering of son preference across Indian districts exhibited distinct regional and temporal patterns by parity.

At parity 1, high son preference clusters in 2002–2004 were concentrated in parts of Gujarat, Haryana, Himachal Pradesh, Karnataka, and Madhya Pradesh. By 2019–2021, these clusters had expanded across nearly all districts of Haryana, Punjab, and northern Madhya Pradesh. Low son preference clusters in 2002–2004 were largely found in northeastern states, Kerala, and parts of West Bengal. Low-low clusters had grown notably in Telangana, Kerala (13 out of 14 districts), and Tamil Nadu (27 districts) by 2019–2021.

At parity 2, high son preference clusters in 2002–2004 spanned Maharashtra (32 districts), Gujarat, Madhya Pradesh, Chhattisgarh, Rajasthan, and parts of Himachal Pradesh. However, by 2019–2021, these clusters had diminished in Maharashtra and Gujarat, while new clusters had emerged across almost all of Haryana, large parts of Bihar (northern and central regions), Uttar Pradesh (southern and western regions), Jharkhand, and Rajasthan (28 of 33 districts). Low-low clusters were consistently observed in the southern and northeastern states throughout the study period, with some expansion into Tripura and West Bengal.

Among parity 3 or higher women, high-high clusters increased from 148 districts in 2002–2004 to 201 in 2007–2008 and then declined to 148 in 2019–2021. Initial clusters were concentrated in Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Punjab, and Rajasthan. By 2019–2021, they persisted mainly in Bihar (33 districts), Haryana (18 districts), Rajasthan (31 districts), and parts of Madhya Pradesh and Uttar Pradesh. Punjab and Maharashtra no longer showed high-high clustering at parity 3 or higher.

Figure 3: LISA map for son preference by parity, India, 2002–2021



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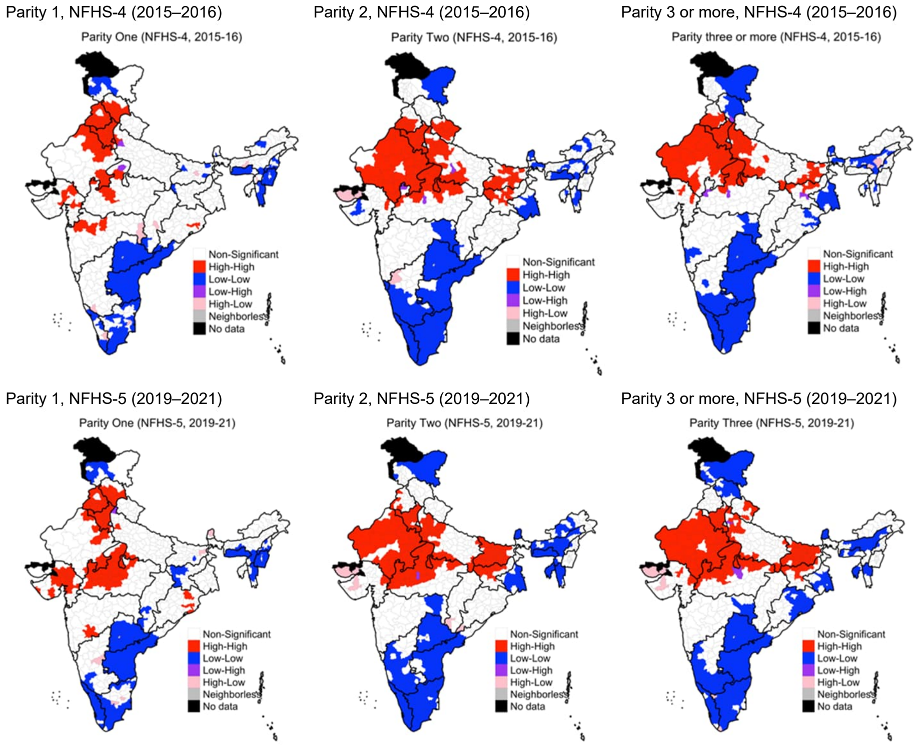
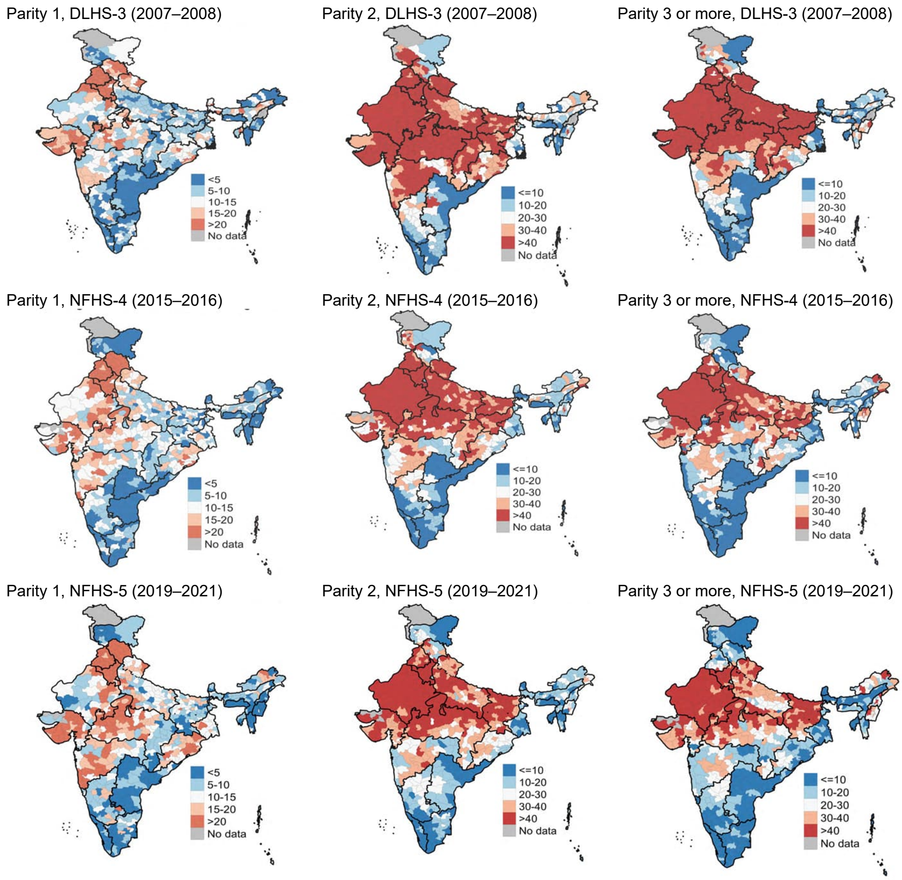


We conducted validation checks to assess the robustness of our estimated trends and patterns. First, NFHS-2 (1998–1999) was excluded due to small district samples and NFHS-3 was excluded (2005–2006) due to missing district codes. We relied on DLHS-2, DLHS-3, NFHS-4, and NFHS-5, which share comparable sampling designs and identical fertility preference questions (Roy and Ram 2004; IIPS 2006, 2010; IIPS and ICF 2017, 2021). We estimated state-level son preference trends across NFHS-2 to NFHS-5. Estimated trends across NFHS-2 to NFHS-5 mirrored our district-level findings – an increase at parity 1 and a decline at parities 2 and 3+. Second, including both pregnant and non-pregnant women in DLHS-3, NFHS-4, and NFHS-5 produced consistent spatial patterns. Third, applying SAE directly to the difference indicator yielded similar spatial trends, with model-based estimates consistently showing lower average sampling variances than direct estimates (Figure 4).

Figure 4: Model-based estimates of son preference among both pregnant and non-pregnant women age 15–49, India, 2002–2021



4. Discussion

Our research presents the first systematic documentation of two decades of spatial trends in son preference by parity across India's districts using SAE methods. The results reveal substantial shifts in district-level son preference between 2002 and 2021. The number of districts exhibiting son preference at parity 1 steadily increased over time. In contrast, at parity 2, the number of such districts rose until 2008 and then began to decline. For parity

3 and above, the number of districts with son preference consistently declined across all four survey rounds. Our findings challenge the assertion by Barman and Sahoo (2022) and Radkar (2018) that son preference has been uniformly declining across all states and subgroups of the Indian population.

When fertility is high and access to sex-selection technology is limited, couples may continue childbearing until achieving the desired number of sons (Arnold 1997; Arnold, Kishor, and Roy 2002; Bongaarts 2013; Clark 2000; Fors and Lindskog 2023; Retherford and Roy 2003). With falling fertility, the pressure to have sons at lower parities, such as parity 1, intensifies (Aksan 2021). Consequently, women at parity 2 or higher are less likely to desire additional children regardless of son composition, consistent with prior state- and district-level analyses (Barman and Sahoo 2021; Radkar 2018; Singh et al. 2022).

Our study documents changing patterns of son preference heterogeneity across districts. Districts in northern, western, and central India exhibited the highest son preference, while those in Andhra Pradesh, Telangana, Kerala, and the Northeast showed consistently low levels. Between 2002 and 2021, son preference at parity 1 expanded geographically, particularly in Haryana, Punjab, and parts of Rajasthan, Gujarat, and Madhya Pradesh – states with persistently skewed sex ratios at birth (Bhat 2002; Das Gupta and Bhat 1997; Saikia et al. 2021; Tong 2022).

For parity 2, districts in Haryana, Rajasthan, western Uttar Pradesh, Bihar, and Madhya Pradesh saw increasing son preference over time. These areas are also marked by high levels of patriarchy (Singh et al. 2021). Son preference among parity 3+ women was most intense in Haryana, Rajasthan, Gujarat, Bihar, and Madhya Pradesh during 2002–2004 but declined in later years. Notably, the trend intensified in high-fertility, patriarchal northern states even as fertility declined.

In contrast, consistently low son preference was found in southern states and the Northeast, particularly Kerala and Meghalaya. These regions rank low in patriarchy and exhibit high female literacy and autonomy, aided by matrilineal kinship structures (Chakraborty and Kim 2010; Dyson and Moore 1983; Malhotra, Vanneman, and Kishor 1995; Singh, Ram, and Ranjan 2007; Subba and Ghosh 2003).

As fertility declined and family size preferences decreased, son preference at parity 1 intensified – a trend missed by attitudinal measures prone to bias (Barman and Sahoo 2021; Radkar 2018). Our parity-specific behavioural indicator offers a clearer understanding of how fertility decline, patriarchy, and spatial context influence son preference and related sex ratio imbalances (Arnold, Kishor, and Roy 2002; Guilmoto 2009, 2012). Government programs such as Beti Bachao Beti Padhao and Sukanya Samriddhi Yojana target these issues, but our findings reveal persistent high son preference clusters across state borders. This underscores the need for culturally sensitive, geographically targeted interventions to effectively challenge entrenched social norms (McDougal et al. 2020; Singh et al. 2022).

5. Study limitations

Our indicator of son preference is intuitive and less prone to reporting biases but may underestimate son preference in areas with high sex-selective abortion or female child mortality (Vanneman, Desai, and Vikram 2012). Although sex differentials in child mortality have declined (Alderman et al. 2021), evidence of sex-selective abortion persists (Saikia et al. 2021). Limitations also arise from reliance on census-derived auxiliary variables, excluding factors like household income or media exposure. Nonetheless, model diagnostics (e.g., R^2 > 50% in most models) confirm robustness. Using both DLHS and NFHS data does not significantly affect trend estimates, and excluding pregnant women has minimal impact.

Our 2019–2021 estimates may be marginally influenced by COVID-19-related disruptions in NFHS-5 data collection, but there is no evidence to indicate any systematic bias by son status. Despite limitations, this study is the first to apply SAE to examine district-level, parity-specific son preference trends in India, revealing heterogeneity masked at higher levels. The integration of census and survey data offers a scalable model for other low- and middle-income countries.

6. Conclusions

Our study reveals clear temporal and spatial heterogeneity in son preference by parity across India’s districts over the past two decades. Son preference at parity 1 has expanded but remains clustered in select districts across seven states, while it has declined at higher parities. Distinct regional patterns – such as Punjab, Himachal Pradesh, and Gujarat at parity 1, Rajasthan and Bihar at higher parities, and Haryana and parts of Madhya Pradesh across all parities – require tailored policies. Our findings underscore the importance of understanding demographic phenomena, such as son preference, which are often shaped by cultural factors and tend to be geographically concentrated at lower administrative levels in India, such as districts. Regular monitoring and further research on links with gender inequality are essential. SAE proves a valuable tool for generating granular local estimates, enabling targeted policy formulation and evaluation in data-poor settings.

7. Data availability statement

This research is based on secondary data in anonymous format from publicly available datasets, found on the DHS Program website (https://dhsprogram.com/methodology/survey/survey-display-355.cfm).

8. Funding statement

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