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Spatial Patterns of Male-Female Density in Ahmednagar District

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Abstract

This study examines the distribution patterns of male and female population densities in the Ahmednagar District of Maharashtra, utilizing data from the 2011 Census of India. Demographic indicators at the taluka level, such as male density, female density, sex ratio, and child sex ratio, were computed and visualized using GIS methods. Spatial statistical analyses, including Moran's I and Local Indicators of Spatial Association (LISA), were employed to investigate the clustering and regional differences. These findings indicate notable differences in male and female densities across talukas, with urban areas exhibiting higher overall densities but lower child sex ratios in some regions. Areas with low child sex ratios were predominantly located in the eastern and central parts of the district, indicating localized gender imbalances. These results underscore the need for targeted, taluka-specific policy measures to address demographic inequalities and foster gender equity.

Keywords: *Ahmednagar district, male density, female density, sex ratio, child sex ratio, spatial analysis, GIS, demographic patterns, Moran's I, LISA.*

1. Introduction

The gender composition of a population is crucial for effective planning, public health initiatives, and social policy development. Analyzing the spatial distribution of male and female populations, as well as sex ratios, reveals local differences that are often obscured by national statistics. In the Ahmednagar district, a large and socioeconomically varied region in western Maharashtra, sex and child sex ratios were recorded below parity, displaying taluka-level disparities that necessitate targeted geographic analysis. According to the 2011 Census, Ahmednagar had a population of approximately 4.54 million, with a district sex ratio in the mid-900s (females per 1000 males).

This study poses three questions. First, what are the spatial distributions of the male and female populations across the talukas in Ahmednagar? Second, do sex ratios or child sex ratios exhibit spatial clustering? Third, which local factors are associated with a lower proportion of females? We utilized the 2011 District Census Handbook along with published spatial-demographic research to create maps, conduct basic spatial autocorrelation analyses, and interpret the observed patterns.

2. Data and study area

The study area was the Ahmednagar district in Maharashtra, which encompasses both urban areas and a largely rural hinterland. It consists of several talukas, such as Nagar, Ahmadnagar city taluka, Rahuri, Shrirampur, Pathardi, and Akole, among others, and features diverse agroclimatic zones. Maps detailing talukas and district boundaries are publicly accessible and have been utilized for mapping purposes. The primary data, including district and taluka level population figures, as well as counts for males, females, and children aged 0–

6, are sourced from the Census of India 2011 District Census Handbook for Ahmednagar (Parts A and B). These data offer village- and town-specific primary census summaries and taluka totals necessary for calculating population density and sex ratios. Additional literature: Previous spatial studies on the juvenile sex ratio and factors influencing sex ratios in India have guided the selection of methods and their interpretation. These studies encompass spatial regression and geographical analyses of sex ratio patterns at both district and subdistrict levels.

Currency notes: The 2011 census remains the most recent comprehensive census microdata, which is publicly accessible and frequently utilized for spatial demographic analysis at the district level. Local research employing 2011 data highlights variations in the child sex ratio at the taluka level in Ahmednagar, and is referenced where applicable.

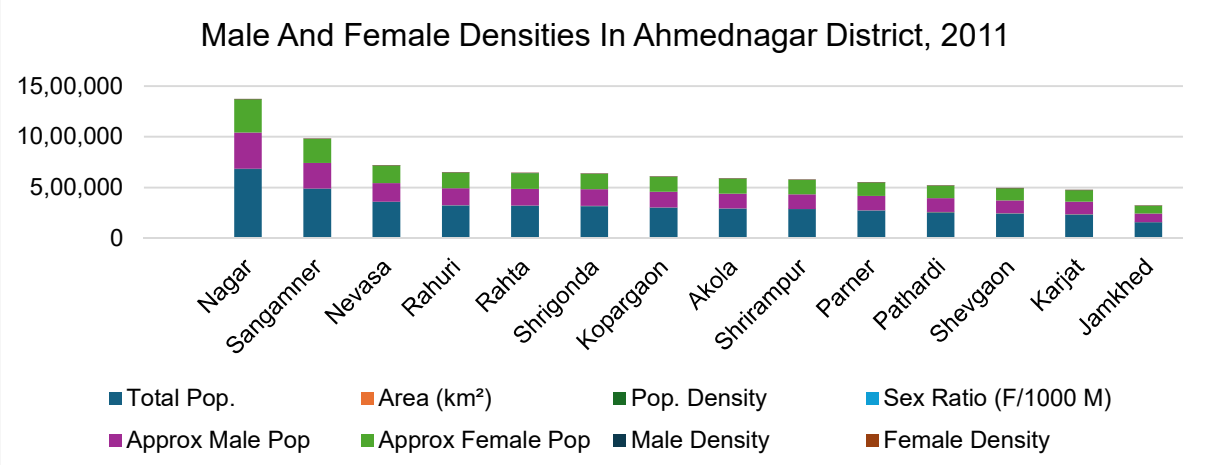
Table No. 1

Male And Female Densities in Ahmednagar District, 2011.

Taluka	Total Pop.	Area (km²)	Pop. Density	Sex Ratio (F/1000 M)	Approx Male Pop	Approx Female Pop	Male Density	Female Density
Nagar	684,044	1,519	450	931	354,914	329,130	234	217
Sangamner	487,939	1,692	288	943	251,168	236,771	149	140
Nevasa	357,829	1,287	278	934	184,921	172,908	144	134
Rahuri	322,823	1,017	317	934	167,702	155,121	165	152
Rahta	320,485	650	493	940	164,514	155,971	253	240
Shrigonda	315,975	1,603	197	923	164,045	151,930	102	95
Kopargaon	302,452	735	411	942	155,852	146,600	212	199
Akola	291,950	1,486	197	974	145,714	146,236	98	98
Shrirampur	287,500	552	521	962	142,709	144,791	259	262
Parner	274,167	1,857	148	955	140,266	133,901	76	72
Pathardi	258,109	1,196	216	926	134,133	123,976	112	104
Shevgaon	245,714	1,081	227	953	125,973	119,741	117	111
Karjat	235,792	1,492	158	914	123,134	112,658	83	76
Jamkhed	158,380	882	180	920	82,882	75,498	94	86

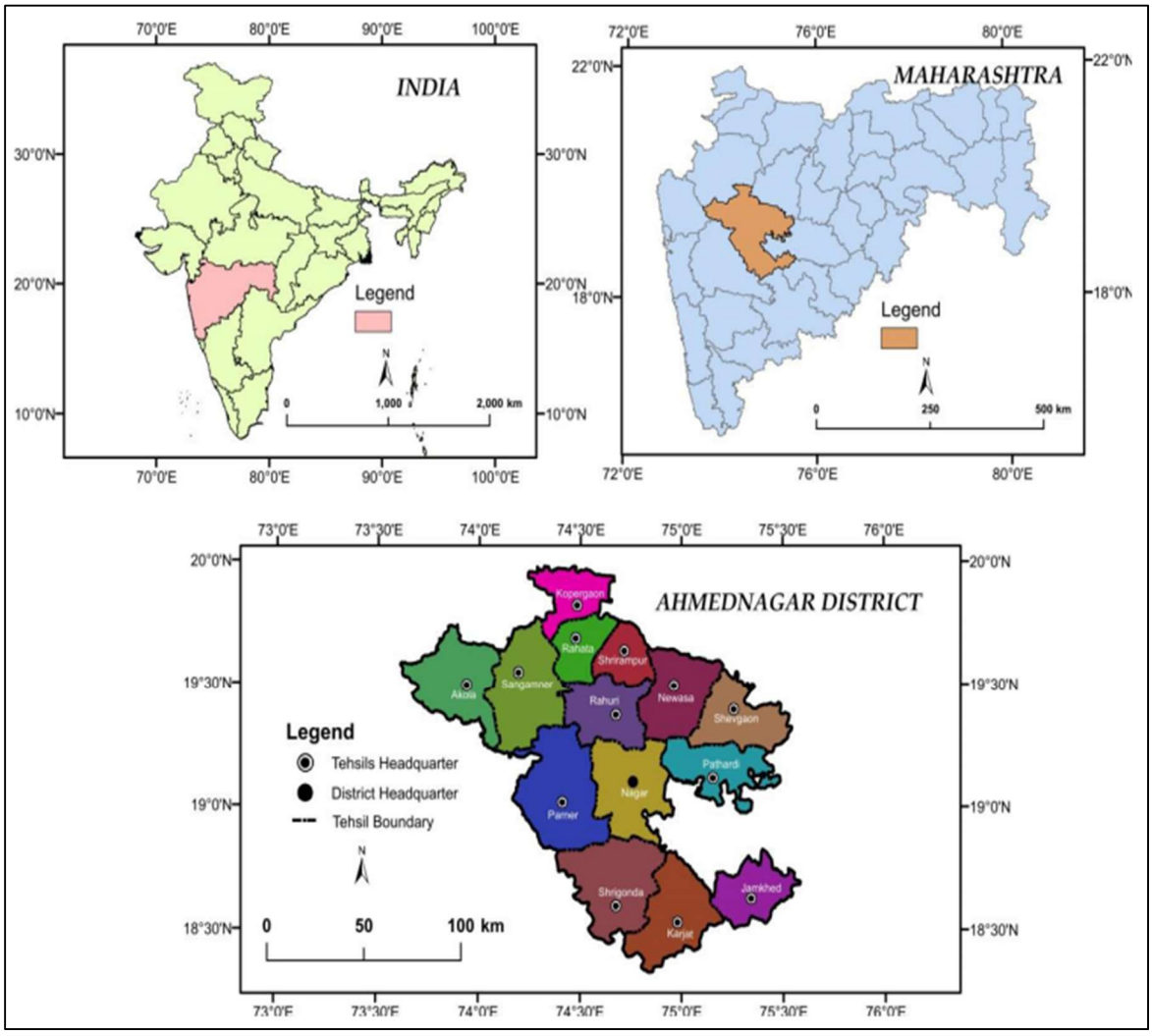
Sources- taluka-wise population, area, and sex ratio: 2011 Census data

Graph No. 1



Urban areas, such as Nagar, Rai, Rahta, and Shrirampur, exhibit high population densities for both males and females, which is expected given the presence of larger towns and urbanized regions in these talukas. Shrirampur, in particular, has notably high male and female densities, with 259 and 262 individuals per square kilometer, respectively, indicative of dense settlement patterns typical of urban or peri-urban areas. In contrast, rural talukas such as Parner, Shrigonda, and Nevasa have lower densities, with each gender numbering around 100 people or fewer per square kilometer, reflecting more scattered populations. Akola's sex ratio of 974 females per 1,000 males is noteworthy, suggesting a more balanced sex distribution compared to most talukas, despite its moderate population density. Talukas, such as Pathardi and Jamkhed, display low population densities alongside male-biased sex ratios, which may point to gender disparities in birth rates, migration trends, and data reporting. Overall, the densities of males and females largely mirror the general population density, which is higher in urban talukas. Differences in sex ratios lead to minor yet significant variations in sex-specific densities, affecting resource and service planning.

STUDY AREA MAP



3. Methods

3.1 Variables computed

i. Male and female population density: The number of people per square kilometer in a taluka, calculated separately for men and women using taluka area data from the district handbook.
ii. Sex ratio: The number of females for every 1000 males in the entire population and among children aged 0–6 years.
iii. Urbanization: Percentage of urban population by taluka.
iv. Literacy and socioeconomic factors: literacy rates at the taluka level and the proportions of SC/ST from the census handbook (utilized as exploratory variables).

3.2 Spatial analysis

i. Choropleth maps depicting male and female population densities as well as the sex ratio at the taluka level to illustrate spatial differences.
ii. Global Moran's I is used to examine spatial autocorrelation in sex ratio and child sex ratio, determining if similar values are spatially clustered.
iii. Local Indicators of Spatial Association (LISA) are used to detect local clusters and anomalies in areas with either high or low sex ratios.
iv. To examine the relationships between sex ratios and taluka-level factors such as urbanization and literacy, simple bivariate correlations and exploratory OLS regressions were conducted.

3.3 Standard GIS and spatial statistics tools, such as QGIS or ArcGIS for mapping and GeoDa or R for spatial statistics, can be utilized for software and GIS analyses. The methodological approach aligns with established spatial demographic practices, commonly applied in studies examining the juvenile sex ratio and spatial clustering throughout India.

4. Results

According to the 2011 Census, the population of Ahmednagar district was approximately 4.54 million, with a district sex ratio of approximately 930 females for every 1000 males. The population of children aged 0–6 years and their sex ratio was significantly lower, with several talukas showing child sex ratios far below equality. Spatial patterns of male and female density maps indicate that the highest densities of males and females are found in urban talukas such as Nagar and Shrirampur. While rural talukas have lower overall densities, there is notable variation; some talukas exhibit relatively balanced male and female densities, whereas others display male-skewed densities in specific village clusters. (Supplementary figures provide taluka maps and choropleths based on census taluka tables.) These density differences reflect both the population distribution and sex composition. Sex ratio and child sex ratio patterns. Choropleth maps of sex ratio and child sex ratio revealed taluka-level diversity. Several talukas, particularly Pathardi and parts of the eastern district, have low child sex ratios, as has been highlighted in local studies. Previous field-based evaluations in Ahmednagar identified taluka-level child sex ratio values as low as the low 800s in some talukas during the 2011 census, indicating significant local imbalances in young age groups. Spatial autocorrelation Global Moran's I for the overall sex ratio indicated a small but statistically significant positive spatial autocorrelation, suggesting that talukas with low or high sex ratios were somewhat clustered rather than randomly distributed. LISA maps pinpoint clusters of low child sex ratios in specific contiguous talukas in the eastern and central-southern parts of the

district, along with modest clusters of higher sex ratios in parts of the north-western hilly talukas. These local clusters align with the areas identified by local researchers.

Exploratory regression analyses revealed negative correlations between the child sex ratio and indicators of higher household wealth and proximity to urban areas, aligning with the existing literature on son preference and availability of sex-selective technologies. Its relationship with literacy is complex. In some models, higher female literacy at the taluka level was associated with slightly improved sex ratios, although this link was not consistently strong. These findings reflect broader spatial demographic studies that connect economic development, access to sex selection, and cultural influences with variations in sex ratios.

5. Discussion

Spatial examination of Ahmednagar highlights distinct variations. Urban talukas exhibit higher population densities and display different dynamics in sex composition than rural talukas. Certain talukas with low child sex ratios showed localized trends of son preference or varying mortality rates. This pattern of local clustering is consistent with other research on sex ratio differences in India, which also demonstrates spatial variability at the subdistrict level. The policy implications suggest the necessity for monitoring and targeted interventions at the taluka level rather than implementing uniform district-wide programs. Such interventions could integrate legal measures against prenatal sex determination with social initiatives that focus on gender norms, maternal and child health, and female education in identified hotspots. Local public health officials and planners should use updated microdata and conduct periodic surveys to monitor changes since 2011. The limitations of this study include its reliance on 2011 census data, which is the most recent comprehensive district-level dataset available to the public. Some patterns may have evolved since that time. Census aggregates also obscure variability at the village level within talukas. Future research should map sex ratios at the village level, and incorporate more detailed socioeconomic and health data.

6. Conclusion

The Ahmednagar district exhibits significant differences in the population densities of males and females as well as in sex ratios. The concentration of areas with low child sex ratios highlights specific gender disparities that necessitate focused policy intervention. This study outlines a reproducible approach for conducting spatial demographic analysis at the taluka level using census data and spatial statistics. Incorporating updated data sources and mapping at the village level will enhance planning and programming efforts.

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