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Spatial Distribution and Socio-Economic Determinants of Anaemia among Women (15–49) in Srinagar District

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Abstract

Background: Anaemia affects more than half of Indian women of reproductive age and is a severe public health problem by WHO criteria. District averages conceal sharp differences between and within districts, and the geography of anaemia in the Kashmir Valley has rarely been examined below the district level.

Objectives: To place Srinagar district within the regional pattern of anaemia in Jammu and Kashmir, to examine its change between 2015–16 and 2019–20, and to identify the prevalence and socio-economic determinants of anaemia among women aged 15–49 in selected localities of the district.

Methods: NFHS-4 (2015–16) and NFHS-5 (2019–20) district fact sheets for all 20 districts of Jammu and Kashmir were analysed with the coefficient of variation, Mann–Whitney U tests and Spearman rank correlation, alongside Census 2011. A household survey of 400 women aged 15–49 in eleven localities of Srinagar combined haemoglobin measurement with a structured questionnaire. Unadjusted associations were tested with Pearson's chi-square, and adjusted odds ratios (AOR) were estimated by binary logistic regression.

Results: In 2019–20, 51.7% of women aged 15–49 in Srinagar were anaemic, the lowest share among Jammu and Kashmir's 20 districts (range 51.7–84.8%; UT 65.9%). Srinagar was one of only two districts where prevalence fell after 2015–16 (from 60.1%); it rose in 18 districts, by up to 37.7 percentage points. Kashmir division districts were more anaemic than Jammu division districts in both rounds (71.1% vs 62.8% in 2019–20; $p = 0.03$). Within the Kashmir division, IFA coverage in pregnancy was strongly and inversely related to anaemia ($\rho = -0.75$, $p = 0.01$). In the household survey, 71.2% of women (285/400) were anaemic, with a mean haemoglobin of 11.15 g/dL. Low household income (AOR 2.29, 95% CI 1.22–4.30) and inadequate consumption of iron-rich foods (AOR 2.80, 95% CI 1.76–4.47) were independently associated with anaemia.

Conclusion: Srinagar's relative advantage reflects its urban character, schooling and supplementation coverage, but anaemia remains a severe public health problem in the district and is worsening among adolescents. Locality-level targeting, adolescent-focused supplementation and dietary counselling are needed.

Keywords: anaemia; women of reproductive age; spatial distribution; socio-economic determinants; NFHS; Srinagar; Kashmir Valley

1. Introduction

Anaemia is among the most widespread and least visible threats to women's health. Globally, about 29% of non-pregnant and 38% of pregnant women were anaemic in 2011 (Stevens et

al., 2013), and iron deficiency is its leading cause (Kassebaum et al., 2014). In women of reproductive age it lowers work capacity and cognitive performance, raises the risk of maternal death and haemorrhage, and is associated with low birth weight and preterm birth (Balarajan et al., 2011). The WHO classifies a prevalence of 40% or more as a severe public health problem (WHO, 2011).

India carries the largest share of this burden. In 2015–16, 53.1% of Indian women aged 15–49 were anaemic, barely 2 percentage points below the 2005–06 level despite four decades of IFA programmes (IIPS & ICF, 2017; Rai et al., 2018). The modest decline between 2006 and 2016 was driven mainly by gains in women's schooling, household wealth, sanitation, IFA consumption and body mass index (Nguyen et al., 2018). Anaemia among Indian women has long been linked to poverty, low education, rural residence, high parity, low dietary iron and the poor bioavailability of non-haem iron in cereal-based diets (Bentley & Griffiths, 2003; Ghosh, 2009; Rammohan et al., 2012; Siddiqui et al., 2017). The Anemia Mukt Bharat strategy (MoHFW, 2018) targets a three-percentage-point annual reduction through supplementation, deworming, behaviour-change communication and testing.

Anaemia is also strongly geographical. Prevalence varies more between and within districts than between social groups, and district averages can conceal clusters of high burden that national programmes miss (Liou et al., 2020; Sharma et al., 2020). Spatial statistics such as Moran's I and local indicators of spatial association (Moran, 1950; Anselin, 1995) are now standard tools for finding such clusters, but they have been applied mostly at national or state scale and rarely within a district.

Jammu and Kashmir presents a striking case. Prevalence among women aged 15–49 rose from 48.9% in 2015–16 to 65.9% in 2019–20 (IIPS, 2020), one of the largest increases recorded in India. Hospital and block-level studies in the Kashmir Valley report very high anaemia in pregnancy, including 91% in a rural block of Bandipora (Kaul et al., 2013) and a high burden in Budgam (Akhter et al., 2019), with iron deficiency the leading cause at a Srinagar tertiary centre (Ara et al., 2018). These studies are clinical and confined to pregnant women. No study has examined anaemia among all women of reproductive age through a geographical lens in Srinagar, the Valley's most urbanised and best-served district.

This paper fills that gap by combining district-level survey data with a locality-level household survey. It asks three questions:

1. How does Srinagar compare with other districts of Jammu and Kashmir in the level of, and change in, anaemia among women aged 15–49, and which district-level conditions accompany these differences?
2. How prevalent is anaemia among women in selected localities of Srinagar?
3. Which socio-economic, demographic, dietary and health-service factors are associated with anaemia among women in Srinagar?

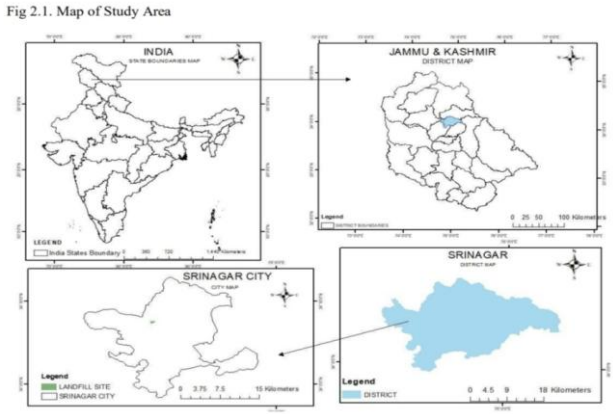
2. Study area

Srinagar district occupies the centre of the Kashmir Valley (33°59′–34°12′ N, 74°41′–74°57′ E) at roughly 1,585 m above sea level (Figure 1). Most of the district is a level alluvial floor

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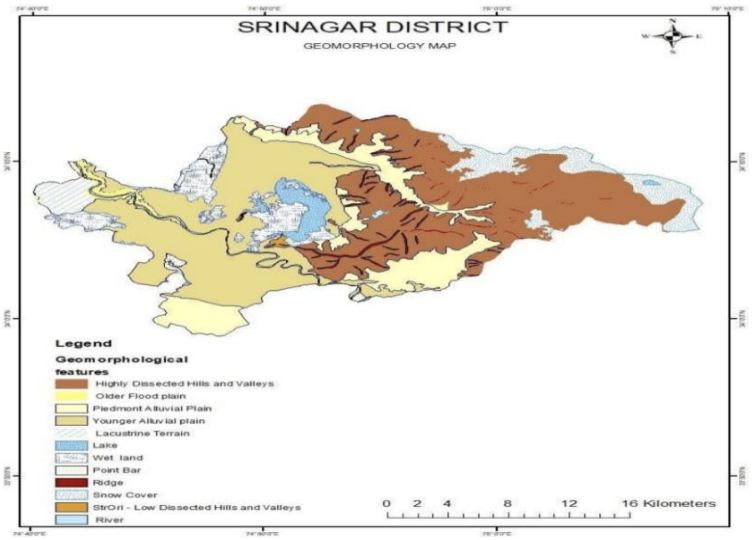
built up by the Jhelum and its feeder streams; the Zabarwan Range rises on its eastern side and the Pir Panjal closes the horizon to the south-west. The Jhelum loops through the city in a series of meanders, splitting it into two banks, while the Dal, Nigeen, Anchar and Khushal Sar lakes and their fringing wetlands have long guided where people settled.

Figure 1. Location of the study area: India, Jammu and Kashmir, Srinagar district and Srinagar city.



The district's landforms fall into three broad zones (Figure 2). The western and central parts are a younger alluvial plain along the Jhelum, fringed by piedmont alluvial plains and remnants of an older floodplain; this is where the old city, the planned colonies and most of the population lie. The north-west holds lacustrine terrain and wetlands around Anchar Lake, and Dal Lake sits at the junction of the plain and the hills. The eastern half is the highly dissected hills, valleys and ridges of the Zabarwan Range, with snow cover on the highest north-eastern slopes and little settlement.

Figure 2. Geomorphology of Srinagar district.



Four seasons are clearly marked. Summer days are mild, generally between 15 °C and 30 °C, whereas December to February brings sub-zero nights, snowfall and the forty-day spell of

severe cold known locally as *Chillai Kalan*. The winter matters for this study because fresh vegetables are scarce for several months, which lowers dietary iron (Section 5.2).

As the summer capital of Jammu and Kashmir, Srinagar concentrates the Valley's administration, commerce, higher education and specialist health services. The 2011 Census counted 1,236,829 residents, 98.6% of them in urban areas (Table 1). Employment is dominated by the tertiary sector — government service, trade and tourism — but craft production, seasonal tourist work and informal daily-wage labour remain the mainstay of many poorer households.

Table 1. Demographic profile of Srinagar district, Census 2011

Indicator	Value
Population	1,236,829
Area (km²)	1,979
Population density (per km²)	625
Urban population (%)	98.6
Sex ratio (females per 1,000 males)	900
Child sex ratio (0–6 years)	865
Literacy, age 7+ (%): total / male / female	69.4 / 76.3 / 61.9
Female literacy, rural areas (%)	43.3
Muslim population (%)	95.2

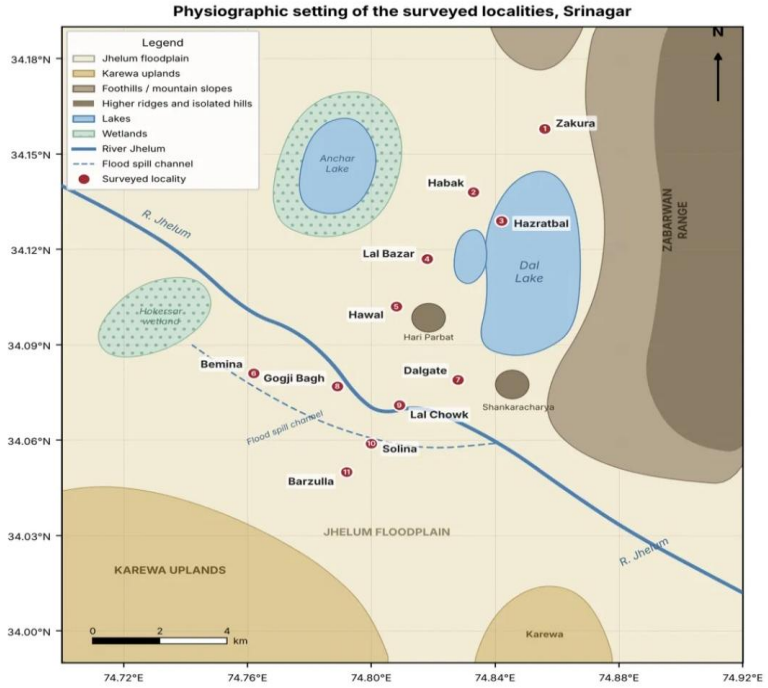
Source: Census of India 2011.

The district's internal geography is uneven. The dense old city along the Jhelum has congested lanes and closely built housing. Planned colonies and newer suburbs on the periphery have wider roads and better services. A thin rural and peri-urban fringe around the Dal and Anchar lakes and in the Zabarwan foothills had female literacy of only 43.3% in 2011. These contrasts in income, schooling, housing density and access to health facilities make the district well suited to studying intra-urban variation in anaemia.

The field survey covered eleven localities chosen to span these settings: Hazratbal, Habak, Zakura, Lal Bazar, Hawal, Dalgate, Lal Chowk, Solina, Gogji Bagh, Bemina and Barzulla (Figure 3). Eight lie on the Jhelum floodplain, from Bemina and Barzulla in the west to Lal Chowk and Dalgate in the centre, while Habak, Hazratbal and Zakura lie along the Dal–Anchar lake belt at the foot of the Zabarwan Range.

Figure 3. Physiographic setting of the eleven surveyed localities, Srinagar. Schematic map; boundaries of physiographic units and locality positions are approximate.

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Schematic map: physiographic units and locality positions are approximate. Compiled by the authors.

3. Data and methods

The study combines two levels of evidence: secondary district-level data that place Srinagar in its regional context, and a primary household survey that resolves the pattern within the district. All data were collected in or before 2020.

3.1 Secondary data

District fact sheets of the fourth and fifth rounds of the National Family Health Survey were used for all 20 districts of Jammu and Kashmir (IIPS & ICF, 2017; IIPS, 2020). NFHS-5 fieldwork in Jammu and Kashmir ran from July 2019 to January 2020; in Srinagar it covered 889 households and 1,030 women. NFHS measures haemoglobin in capillary blood with a HemoCue analyser and adjusts values for altitude and smoking. Women are classified as anaemic below 12.0 g/dl (non-pregnant) or 11.0 g/dl (pregnant), following WHO (2011).

The outcome was the percentage of all women aged 15–49 who were anaemic. Six district-level correlates came from the same fact sheets: women with 10 or more years of schooling; women with body mass index below 18.5 kg/m²; households using clean cooking fuel; population in households with improved sanitation; population with an improved drinking-water source; and mothers who consumed IFA for at least 100 days in pregnancy. Demographic data came from Census 2011.

3.2 Primary survey

A cross-sectional household survey was carried out in eleven localities of Srinagar district (Section 2), selected purposively to represent the old city, planned colonies and peri-urban or lake-side settlements. In all, 400 women aged 15–49 were surveyed.

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3.3 Analysis

For the district data, prevalence and change between rounds were mapped, inter-district disparity was measured with the coefficient of variation, the Kashmir and Jammu divisions were compared with the Mann–Whitney U test, and associations with the six correlates were measured with Spearman's rank correlation for all 20 districts and for the 10 Kashmir division districts. With 20 units, these associations are ecological and descriptive.

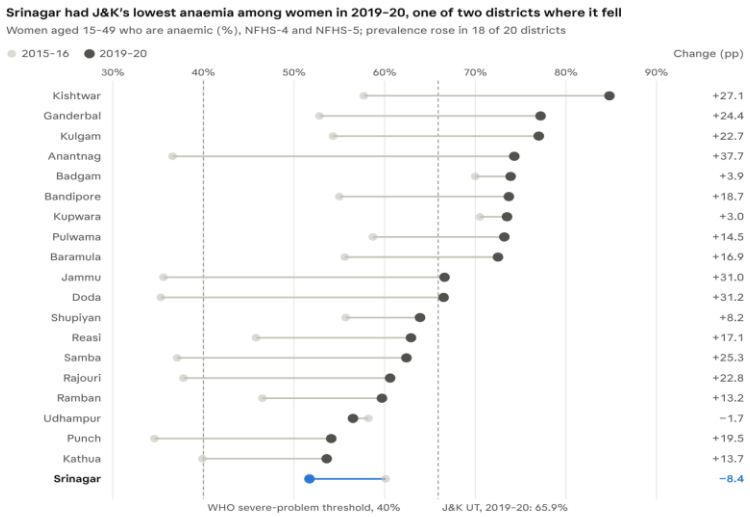
For the survey data, associations between anaemia and individual characteristics are examined with Pearson's chi-square tests, then with binary logistic regression reporting adjusted odds ratios (AOR) and 95% confidence intervals ($\alpha = 0.05$).

4. Results

4.1 Srinagar in the regional pattern

Srinagar had the lowest prevalence of anaemia among women aged 15–49 of all 20 districts of Jammu and Kashmir in 2019–20, at 51.7%, against 65.9% for the Union Territory and a range of 51.7% (Srinagar) to 84.8% (Kishtwar) (Figure 4). It was one of only two districts, with Udhampur, where prevalence fell after 2015–16; in the other 18 it rose, by as much as 37.7 percentage points in Anantnag.

Figure 4. Anaemia among women aged 15–49 by district, Jammu and Kashmir, 2015–16 and 2019–20



Source: NFHS-5 district fact sheets, Jammu and Kashmir (IIPS, 2020), which report NFHS-4 (2015–16) values alongside · 20 districts

The rise narrowed the gaps between districts: the coefficient of variation fell from 23.1% to 13.8% as low-prevalence districts caught up with high ones. The divide between divisions persisted. Kashmir division districts averaged 71.1% in 2019–20 against 62.8% in the Jammu division (Mann–Whitney U = 79, p = 0.03), having averaged 56.9% and 42.8% in 2015–16 (p = 0.01). Srinagar is therefore exceptional within its own division, where every other district exceeded 63%.

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4.2 Change within Srinagar

Srinagar's improvement was confined to adult women. Anaemia among non-pregnant and pregnant women fell, but rose sharply among adolescent women and children (Table 2).

Table 2. Anaemia and related indicators in Srinagar district, NFHS-4 and NFHS-5

Indicator	2015–16 (%)	2019–20 (%)	Change (pp)
All women 15–49, anaemic	60.1	51.7	−8.4
Non-pregnant women 15–49, anaemic	60.7	52.5	−8.2
Pregnant women 15–49, anaemic	(44.5)	38.8	−5.7
Women 15–19, anaemic	60.7	69.9	+9.2
Children 6–59 months, anaemic	51.4	77.0	+25.6
Women with 10+ years of schooling	45.4	60.5	+15.1
Mothers who took IFA for 100+ days in pregnancy	27.1	34.1	+7.0
Women with BMI below 18.5 kg/m²	4.3	3.5	−0.8
Women overweight or obese	40.8	27.8	−13.0
Population with improved sanitation	68.0	86.8	+18.8
Households using clean cooking fuel	97.0	98.4	+1.4
Households with health insurance coverage	2.4	17.9	+15.5

Source: NFHS-5 district fact sheet, Srinagar (IIPS, 2020). Figures in parentheses are based on 25–49 unweighted cases.

The 9.2-point rise among women aged 15–19 runs against the overall decline: in 2019–20, seven in ten adolescent women in Srinagar were anaemic. Srinagar ranked first of 20 districts in clean cooking fuel, second in sanitation, fourth in women's schooling and safe drinking water, and fifth in IFA coverage in pregnancy.

4.3 District-level correlates

Across all 20 districts, none of the six household and service indicators was significantly associated with anaemia in either round (Table 3). Kashmir division districts had better sanitation and cooking fuel than Jammu division districts but higher anaemia, so amenities and anaemia did not move together at UT scale. Within the Kashmir division, however, districts where more mothers had taken IFA for 100 days or more had markedly less anaemia in 2019–20 ($\rho = -0.75$, $p = 0.01$), and women's schooling showed a weaker inverse association ($\rho = -0.57$, $p = 0.08$).

Table 3. Spearman rank correlation between district anaemia among women aged 15–49 and selected correlates

Correlate	All districts, 2015–16 (n = 20)	All districts, 2019–20 (n = 20)	Kashmir division, 2019–20 (n = 10)
Women with 10+ years of schooling	−0.19 (0.42)	−0.26 (0.27)	−0.57 (0.08)
Women with BMI <18.5 kg/m²	−0.22 (0.35)	0.08 (0.72)	0.18 (0.63)
Households using clean cooking fuel	0.33 (0.15)	0.15 (0.52)	−0.16 (0.66)
Population with improved sanitation	−0.02 (0.92)	0.11 (0.64)	−0.35 (0.33)

Population with improved drinking water	0.22 (0.34)	0.28 (0.24)	−0.12 (0.75)
Mothers who took IFA for 100+ days	−0.05 (0.85)	−0.04 (0.88)	−0.75 (0.01)

Values are Spearman's ρ (two-sided p). Source: computed from NFHS-4 and NFHS-5 district fact sheets.

4.4 Anaemia in the household survey

Of the 400 women surveyed, 285 (71.2%) were anaemic, and their mean haemoglobin was 11.15 g/dL. Survey prevalence is thus well above the district's NFHS-5 estimate of 51.7% (Section 5.3).

4.5 Socio-economic determinants

In the bivariate analysis, dietary pattern was the only characteristic significantly associated with anaemia (χ^2 test, $p < 0.001$); no other socio-economic, demographic or reproductive characteristic showed a significant unadjusted association.

In the adjusted model, two factors remained significant (Table 4). Women in low-income households had more than twice the odds of anaemia of those in high-income households (AOR 2.29, 95% CI 1.22–4.30; p = 0.010). Women with inadequate consumption of iron-rich foods had nearly three times the odds of those with an adequate diet (AOR 2.80, 95% CI 1.76–4.47; $p < 0.001$). No other variable was significant at $p < 0.05$.

Table 4. Binary logistic regression of anaemia among surveyed women (n = 400)

Variable	Category	AOR	95% CI	p
Household income	High (ref.)	1.00	—	—
	Low	2.29	1.22–4.30	0.010
Consumption of iron-rich foods	Adequate (ref.)	1.00	—	—
	Inadequate	2.80	1.76–4.47	< 0.001

Source: field survey. AOR = adjusted odds ratio; CI = confidence interval; ref. = reference category. Only variables significant at $p < 0.05$ are shown.

5. Discussion

5.1 Srinagar as a relative exception

Srinagar's position at the bottom of the regional distribution, and its decline while 18 districts worsened, fit the drivers identified for India as a whole. Gains in women's schooling, wealth, sanitation and IFA consumption accounted for much of the national fall in anaemia between 2006 and 2016 (Nguyen et al., 2018). Srinagar ranks at or near the top of Jammu and Kashmir on each, and its women gained most in schooling (+15.1 points) and sanitation (+18.8 points) between rounds. Its urban character also places women close to secondary and tertiary facilities, where iron deficiency is recognised and treated (Ara et al., 2018).

The advantage is relative, not absolute. At 51.7%, prevalence remains above the WHO threshold of 40% for a severe public health problem (WHO, 2011), and it worsened among adolescent women and children. The divergence between adult and adolescent women suggests that gains reached women in contact with antenatal care, through IFA, but not girls

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before marriage and pregnancy — a group national programmes have long reached poorly (Bharati et al., 2009).

5.2 The Kashmir–Jammu paradox

The Kashmir division had more anaemia than the Jammu division in both rounds despite better sanitation and cooking fuel, and amenities were unrelated to anaemia across the UT. Household infrastructure therefore does not appear to be the binding constraint in the Valley. Three explanations deserve testing.

First, diet and season. The Kashmiri diet is rice-based, and the long, cold winter (Section 2) restricts fresh vegetables for several months. Salt tea (*noon chai*) is commonly drunk with meals, and tea polyphenols can cut non-haem iron absorption by more than half (Hurrell et al., 1999). Second, service delivery: within the Kashmir division, districts with the best IFA coverage in pregnancy had the least anaemia ($\rho = -0.75$), pointing to supplementation as a lever where it reaches women (Rai et al., 2018). Third, measurement: NFHS adjusts haemoglobin for altitude, so the Valley's 1,585 m elevation should not inflate prevalence. Capillary samples can read lower than venous blood, however (Neufeld et al., 2019), and the Indian cut-offs are debated (Varghese et al., 2019). Both rounds used the same protocol, so comparisons between districts and over time hold, but the scale of the 2019–20 rise warrants caution.

5.3 Why the district is not enough

District averages hide clusters of high burden (Liou et al., 2020; Sharma et al., 2020). The survey found anaemia in 71.2% of women, almost 20 points above NFHS-5's 51.7% for the district. The gap may reflect the survey's purposive inclusion of the old city and lake-side settlements, where burden is likely higher, as well as differences in haemoglobin method and season. Within the sample, income and diet, not schooling or reproductive history, were what set anaemic women apart. Low-income households and women eating too few iron-rich foods carried the highest odds, consistent with the link between poverty, diet and anaemia found across India (Bentley & Griffiths, 2003; Ghosh, 2009). In Srinagar these two factors overlap with place: households dependent on seasonal tourism and informal wages are concentrated in the old city and peri-urban fringe, and their incomes fall in winter, when fresh food is scarcest.

5.4 Policy implications

1. **Target adolescents.** Strengthen weekly IFA supplementation and haemoglobin screening in schools and colleges, since anaemia among women aged 15–19 rose to 69.9%.
2. **Extend IFA coverage beyond pregnancy.** Only 34.1% of mothers in Srinagar took IFA for 100 days, and the Kashmir division data suggest coverage is closely tied to prevalence.
3. **Address dietary absorption.** Counsel women to separate tea from meals and pair meals with vitamin C sources, and promote winter availability of iron-rich foods through the public distribution system.

4. **Target by locality, not by district.** Use ward-level mapping to direct Anemia Mukt Bharat test-and-treat camps to the highest-burden localities.
5. **Monitor with comparable measures.** Add venous haemoglobin testing in a sub-sample of district surveys to calibrate capillary estimates.

5.5 Limitations

The district analysis is ecological, uses 20 units and cannot establish individual-level associations. Fact-sheet indicators are aggregate percentages without confidence intervals, and some Srinagar estimates rest on small subsamples, such as the 2015–16 figure for pregnant women. Capillary measurement may overstate prevalence. The survey is cross-sectional, so its associations are not causal. Its 400 women were drawn from eleven purposively chosen localities, which limits generalisation to the whole district.

6. Conclusion

Srinagar had the lowest anaemia among women of reproductive age in Jammu and Kashmir in 2019–20 and was one of only two districts where it fell. Yet more than half its women remain anaemic, seven in ten adolescent women are anaemic, and the Kashmir division as a whole carries a heavier burden than the Jammu division despite better household amenities. The district's sharp internal contrasts — between the old city, planned colonies and the lake-side fringe — mean that a single district figure is a poor guide to where effort is needed. The household survey shows that the burden is heaviest among low-income women and those with inadequate intake of iron-rich foods. Reducing anaemia in Srinagar will depend on reaching adolescents, extending supplementation, changing dietary practices that limit iron absorption, and directing effort to the localities where the burden is concentrated.

Declarations

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflict of interest: The author declares no conflict of interest.

Ethics statement: Participation in the household survey was voluntary, and informed consent was obtained from all respondents, with consent from a parent or guardian for respondents under 18.

Data availability: NFHS fact sheets are publicly available from the International Institute for Population Sciences. Survey data are available from the corresponding author on reasonable request.

Author contribution: Syed Binish Gillani conceived the study, collected and analysed the data, and wrote the manuscript.

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