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# Mapping Anaemia Inequality: A Regional Analysis of Socio-Economic Factors Among Women of Reproductive Age in India

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**Abstract:** *Anaemia prevalence and regional differences in women of reproductive age in India are examined using socio-economic, demographic, and cultural parameters. This research uses National Family Health Survey 5 (NFHS-5) data and the Alkire-Foster (2011) method to produce the multidimensional poverty index (MPI) for a detailed region-wise examination. Anaemia is examined in relation to multidimensional poverty, household characteristics, dietary patterns, healthcare access, and socio-cultural impacts using descriptive analysis and logistic regression. Anaemia prevalence varies by area, with East India having the highest rate at 66.65% and the Union Territories the lowest. Anaemia is significantly correlated with the MPI, showing that regions with high poverty rates have more anaemics. Anaemia is predicted by multidimensional poverty, rural residence, food, and prenatal care according to logistic regression. Multidimensionally poor and rural women are more likely to have anaemia. Anaemia risk decreases with dietary diversity, especially non-vegetarian meals. This study shows the complex links between socio-economic, cultural, and regional factors affecting the incidence of anaemia among Indian women of reproductive age. The findings show that focused initiatives are needed to alleviate these inequities, especially in disadvantaged regions. These data can help policymakers combat anaemia and improve women's health in India.*

***Keywords:*** Anaemia; Multidimensional poverty index; Women of reproductive age; Regional disparities
***JEL Classification:*** I14, I32, I38

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## 1. Introduction

Anaemia, characterised by insufficient haemoglobin levels in the blood, remains a pervasive global health challenge, with a disproportionate impact on women of reproductive age in low- and middle-income countries (WHO, 2024). This condition, defined by the WHO as haemoglobin levels below 12 g/dL in non-pregnant women and under 11 g/dL in pregnant women, poses significant risks to maternal health, including increased complications and mortality rates (WHO, 2024). Among the various forms of anaemia, iron deficiency anaemia stands out as the most prevalent, affecting over 1.62 billion individuals worldwide, primarily due to inadequate dietary intake and limited access to healthcare services (Mawani et al., 2016). The multifactorial nature of anaemia, influenced by a complex interplay of socio-economic and biological factors, further complicates efforts to address this health issue (Adamu et al., 2017).

The complexity mentioned above is particularly evident in India, where despite the implementation of national initiatives, such as the Anaemia Mukt Bharat (AMB) strategy, the prevalence of anaemia among women of reproductive age remains alarmingly high, exceeding 50% at the national level (MoHFW, 2022; Sharif et al., 2023). The persistent high rates of anaemia in India, despite targeted interventions, underscore the need for a more nuanced understanding of the factors contributing to this public health challenge. Regional variations in anaemia prevalence, coupled with the influence of multidimensional poverty and diverse socio-economic determinants, necessitate a comprehensive analysis to inform more effective strategies for anaemia prevention and control.

This study aims to investigate the complex landscape of anaemia among Indian women of reproductive age, with a focus on examining regional disparities in anaemia prevalence across India, analysing the impact of multidimensional poverty on anaemia rates, exploring the influence of various socio-economic and demographic factors on anaemia status and assessing the effectiveness of current interventions and identifying areas for improvement. By elucidating these aspects, this research seeks to contribute valuable insights to the ongoing efforts to combat anaemia in India and inform evidence-based policy recommendations for more targeted and effective interventions.

## 2. Literature Review

Building upon the global health concern of anaemia, this literature review delves deeper into its multifaceted nature, particularly in the context of Indian women of reproductive age. The review synthesises current research, highlighting the complex interplay of factors contributing to the persistently high anaemia rates in India. Nutritional deficiencies, particularly iron, folate, and vitamin B12, form the physiological basis of anaemia (Green & Miller, 2023).

In 2024, WHO reported that significant regional variations in anaemia prevalence, with South Asia and Sub-Saharan Africa experiencing disproportionately high rates. These disparities are attributed to a combination of factors, including dietary habits, healthcare infrastructure, and socio-economic conditions. Studies from Malawi (Adamu et al., 2017) and East Africa (Teshale et al., 2020) underscore the increased anaemia risk for rural populations, often due to limited access to nutritious food and healthcare services. Low-income limits women's access to nutritious food, which reduces fruit and vegetable intake, leading to poor health outcomes (Cheah et al., 2024). Studies in Pakistan (Qadir et al., 2022) and Nepal (Sunuwar et al., 2020) emphasise the critical role of micronutrient deficiencies, particularly iron, vitamin B12, and folate, in anaemia prevalence. These findings are especially relevant for younger women. In the Indian context, Kishore et al. (2020) and Mishra et al. (2021) highlight how nutritional deficiencies, compounded by limited healthcare access and cultural dietary practices, significantly contribute to anaemia. The increased physiological demands during pregnancy and lactation further exacerbate the issue (Kishore et al., 2020). The multifaceted nature of anaemia in India is evident in studies emphasising the role of socio-economic factors. Bharati et al. (2008) discuss how poverty, gender inequality, and low education levels restrict access to nutritious food and healthcare, thereby increasing anaemia risk.

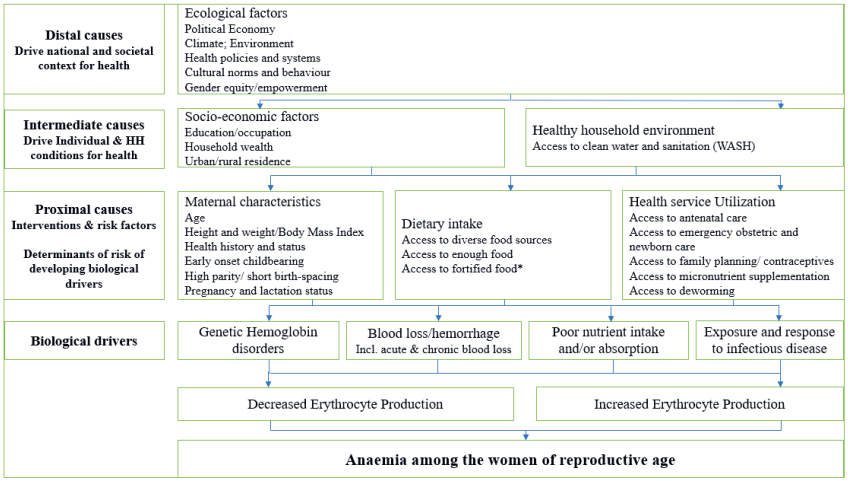
Cultural practices, such as early marriage and childbearing, also contribute significantly to the problem (Diamond-Smith et al., 2016). These findings align with the broader global patterns observed in low- and middle-income countries. The National Family Health Survey 5 (NFHS-5) 2019–2021 reports a 57% anaemia prevalence among women aged 15 to 49 in India (MoHFW, 2022). However, this national average mask significant

regional variations. Studies from Uttar Pradesh (Sharma et al., 2024) report alarmingly high rates, necessitating context-specific interventions. Even urban areas, despite better resource access, face challenges. Research in Mumbai (Lilare & Sahoo, 2017) and other urban settings (Pal & Shekhar, 2024) reveals significant anaemia prevalence influenced by education, socioeconomic status, diet, and high-risk fertility behaviours. Recent studies have expanded beyond nutritional factors to explore other potential contributors to anaemia. Jacob and Saggu (2024) highlight the role of menstrual hygiene practices, correlating hygienic practices with socioeconomic status. This underscores the need for comprehensive approaches addressing both nutritional and socio-economic factors.

Additionally, Adhikary et al. (2024) investigate the relationship between contraceptive methods and anaemia, finding higher anaemia odds among women using traditional contraceptive methods. Recognising the multidimensional nature of anaemia, India launched the AMB strategy to reduce anaemia through targeted interventions and enhanced health systems (Joe et al., 2022). Despite these efforts and improvements in health indicators like access to clean water and sanitation, NFHS-5 data reveal persistent anaemia prevalence (Tripathi et al., 2023). This persistence highlights the need for multifaceted public health strategies to effectively manage and reduce anaemia in India.

While existing literature provides valuable insights into the complex nature of anaemia among Indian women of reproductive age, there remains a need for comprehensive region-wise analysis. This study aims to address this gap by examining the interplay of multidimensional poverty and socio-economic determinants using NFHS-5 data, contributing to a more nuanced understanding of this persistent public health challenge in India. Owais et al. (2021) develop a conceptual framework derived from various literature and review articles to aid in the identification and interpretation of determinants of anaemia among women of reproductive age, encompassing individual and household-level indicators, as well as nutrition-specific and -sensitive interventions, programmes, and policies (Figure 1).

**Figure 1**: Conceptual framework of WRA anaemia determinants and drivers




## 3. Data and Methodology

This study leverages data from the NFHS-5 (2019–2021), which employs a stratified, multistage, cluster sampling method to ensure representative data collection on various population, health, and nutrition indicators across India. The analysis focuses on 724,115 women aged 15 to 49 from seven geographical regions: North, Central, West, East, South, and Northeast India, and the Union Territories. Additionally, data from 636,699 household are used to calculate the multidimensional poverty index (MPI) across these regions. The primary aim is to explore the prevalence and determinants of anaemia among women of reproductive age. Anaemia severity, the dependent variable, is categorised as mild, moderate, or severe based on haemoglobin levels. Independent variables include socio-demographic factors such as age, education, economic status, marital status, and pregnancy status.

The study also applies the Alkire-Foster (2011) method to assess multidimensional poverty, aligning with the global MPI framework. This method uses a composite index with three dimensions: education, health, and standard of living. Education includes years of schooling and attendance, health covers child mortality and nutrition, and standard of living encompasses electricity, sanitation, water, housing, cooking fuel, and assets. The MPI is calculated as the geometric mean of normalised scores across these dimensions.

To identify socio-economic factors associated with anaemia, a logistic regression model is used, with statistical significance assessed via the z-test. Analyses are conducted using STATA 17 software. This methodological approach provides a comprehensive examination of the socio-economic factors influencing anaemia prevalence, offering valuable insights into the health and well-being of women across India's diverse regions.

**Table 1**: Global MPI—Dimensions, indicators, deprivation cutoffs, and weights

| Dimensions | Indicator | Deprived if... | SDG area | Weight |
|---|---|---|---|---|
| Health | Nutrition | Any person under 70 years of age for whom there is nutritional information is undernourished [1] | SDG 2 | 1/6 |
| | Child mortality | A child under 18 has died in the household in the five-year period preceding the survey [2] | SDG 3 | 1/6 |
| Education | Years of schooling | No eligible household member has completed six years of schooling [3] | SDG 4 | 1/6 |
| | School attendance | Any school-aged child is not attending school up to the age at which he/she would complete Class 8 [4] | SDG 4 | 1/6 |
| Living standards | Cooking fuel | A household cooks using solid fuel, such as dung, agricultural crop, shrubs, wood, charcoal, or coal [5] | SDG 7 | 1/18 |
| | Sanitation | The household has unimproved or no sanitation facility or it is improved but shared with other households [6] | SDG 6 | 1/18 |
| | Drinking water | The household's source of drinking water is not safe or safe drinking water is a 30-minute or longer walk from home, round trip [7] | SDG 6 | 1/18 |
| | Electricity | The household has no electricity [8] | SDG 7 | 1/18 |
| | Housing | The household has inadequate housing materials in any of the three components: floor, roof, or walls [9] | SDG 11 | 1/18 |
| | Assets | The household does not own more than one of these assets: radio, TV, telephone, computer, animal cart, bicycle, motorcycle, or refrigerator, and does not own a car or truck. | SDG 1 | 1/18 |

Source: Alkire & Foster (2011). Notes: The global MPI is related to the following SDGs: no poverty (SDG 1), zero hunger (SDG 2), health and well-being (SDG 3), quality education (SDG 4), clean water and sanitation (SDG 6), affordable and clean energy (SDG 7), and sustainable cities

and communities (SDG 11). [1] Children under 5 years (60 months and younger) are considered undernourished if their z-score of either height-for-age (stunting) or weight-for-age (underweight) is below minus two standard deviations from the median of the reference population. Children 5–19 years (61–228 months) are identified as deprived if their age-specific body mass index (BMI) cutoff is below minus two standard deviations. Adults aged 20 to 70 years (229–840 months) are considered undernourished if their BMI is below 18.5 m/kg$^2$. [2] The child mortality indicator of the global MPI is based on birth history data provided by mothers aged 15 to 49. In most surveys, men also provide information on child mortality, but this lacks the date of birth and death of the child. Hence, the indicator is constructed solely from mothers. However, if the data from the mother is missing, and if the male in the household reports no child mortality, then we identify no child mortality in the household. [3] If all individuals in the household are in an age group where they should have formally completed six or more years of schooling, but none have this achievement, then the household is deprived. However, if any individuals aged 10 years and older reported six years or more of schooling, the household is not deprived. [4] Data for the age children start compulsory primary school obtained from DHS or MICS survey reports, and Unesco's UIS Data Browser. [5] Definitions of solid fuel follow the survey report. [6] A household is considered non-deprived in sanitation if it has some type of flush toilet or latrine, or ventilated improved pit or composting toilet, provided that they are not shared. Definitions of improved sanitation follow the survey report. [7] A household is considered non-deprived in drinking water if the water source is any of the following types: piped water, public tap, borehole or pump, protected well, protected spring, or rainwater. It must also be within a 30-minute walk, round trip. Definitions of improved drinking water follow the survey report. [8] A small number of countries do not collect data on electricity because of 100% coverage. In such cases, we identify all households in the country as non-deprived in electricity. [9] Deprived if floor is made of natural materials (mud/clay/earth, sand or dung) or if dwelling has no roof or walls or if either the roof or walls are constructed using natural or rudimentary materials such as such as carton, plastic/polythene sheets, bamboo with mud/stone with mud, loosely packed stones, uncovered adobe, raw/reused wood, plywood, cardboard, unburnt brick or canvas/tent. Definitions of natural and rudimentary materials follow the classification used in country-specific DHS or MICS questionnaires.

In this study, the deprivation score for each individual is calculated as a weighted sum of the deprivations experienced across ten indicators. This score ranges from 0 to 1, where a score of 0 indicates no deprivation, and a score of 1 indicates deprivation across all indicators. An individual is classified as multidimensionally poor if their deprivation score is 0.33 or higher, aligning with the global MPI standards. The analysis aggregates individual-level data to derive household-level insights. Three summary measures are employed to characterise multidimensional poverty in seven regions, MPI, the headcount ratio (H), and the intensity of poverty (A). The MPI is calculated as the product of H and A, encapsulating both the incidence and intensity of poverty. H represents the proportion of the

population that is multidimensionally poor, thus indicating the incidence of poverty. A is the average proportion of deprivations experienced by the poor, reflecting the depth of poverty (Das et al., 2022). The aggregate deprivation score of the *i*-th household ($c_i$) is given by:

$$c_i = \sum_{j=1}^{10} w_j d_{ij}$$

The multidimensional headcount ratio (H) is the ratio of multidimensionally poor people to the total population. In percentage form, it is expressed as:

$$H = \frac{\sum_{i=1}^{q} W_i h_i}{\sum_{i=1}^{n} W_i h_i} \times 100$$

The intensity of multidimensional poverty (A) reflects the average deprivation score of the multidimensionally poor people. In percentage form, it is expressed as:

$$A = \frac{\sum_{i=1}^{q} W_i h_i c_i(k)}{\sum_{i=1}^{q} W_i h_i} \times 100$$

The multidimensional poverty index (MPI) is the ratio of aggregate deprivation score of multidimensional poor people to total population:

$$MPI = \frac{\sum_{i=1}^{q} W_i h_i c_i(k)}{\sum_{i=1}^{n} W_i h_i}$$

$$= \frac{\sum_{i=1}^{q} W_i h_i}{\sum_{i=1}^{n} W_i h_i} \times \frac{\sum_{i=1}^{q} W_i h_i c_i(k)}{\sum_{i=1}^{q} W_i h_i}$$

$$MPI = H \times A$$

Total population constituted with $h_i$ and $W_i$ can be expressed as:

$$\sum_{i=1}^{n} W_i h_i = \sum_{i=1}^{n_1} W_i h_i + \sum_{i=1}^{n_2} W_i h_i + \cdots + \sum_{i=1}^{n_m} W_i h_i$$

The selection of logistic regression for analysing anaemia's relationship with socio-economic and demographic factors among women of reproductive age is theoretically justified through several key principles. First, as highlighted by Peng et al. (2002), logistic regression is particularly suitable for health outcome research where the dependent variable is dichotomous, such as the presence or absence of anaemia. The method's theoretical foundation in probability theory allows for modelling complex relationships while maintaining interpretability of results (Hosmer & Lemeshow, 2013). Furthermore, logistic regression ability to handle multiple independent variables simultaneously aligns with the social determinants of health framework proposed by WHO (2010), which emphasises the interconnected nature of health outcomes. The model's capacity to estimate odds ratios provides meaningful interpretations of risk factors, making it valuable for public health research and policy implications (Agresti, 2013). Additionally, as noted by Vittinghoff et al. (2012), logistic regression's robustness to violations of normality assumptions and its ability to control for confounding factors make it particularly appropriate for epidemiological studies examining multiple socio-economic determinants. Furthermore, it enables the inclusion of multiple covariates to assess their independent and combined effects, aligning with theoretical frameworks that emphasise the complex interplay of determinants at various levels (Grossman, 2000). This approach also allows for the control of confounding variables, ensuring that the observed associations are not spurious.

The logistic regression equation is given below:

$$
\begin{aligned}
log\left(\frac{Having\ Anaemia_i}{1 - Having\ Anaemia_i}\right) &= \alpha + \beta_1 Residence_i + \beta_2 ANC\ Visits_i + \beta_3 Diet_i \\
&+ \beta_4 Currently\ Pregnant_i + \beta_5 Region_i + \beta_6 Wealth_i + \beta_7 Iron\ Intake_i \\
&+ \beta_8 Caste_i + \beta_9 Currently\ Breastfeeding_i + \beta_{10} Religion_i \\
&+ \beta_{11} Presence\ of\ water\ for\ handwash_i + \beta_{12} Use\ of\ Soap_i \\
&+ \beta_{13} Mensuration\ in\ last\ 6\ weeks_i + \beta_{14} Family\ Size_i \\
&+ \beta_{15} Multidimensional\ Poor_i + \mu_i
\end{aligned}
$$

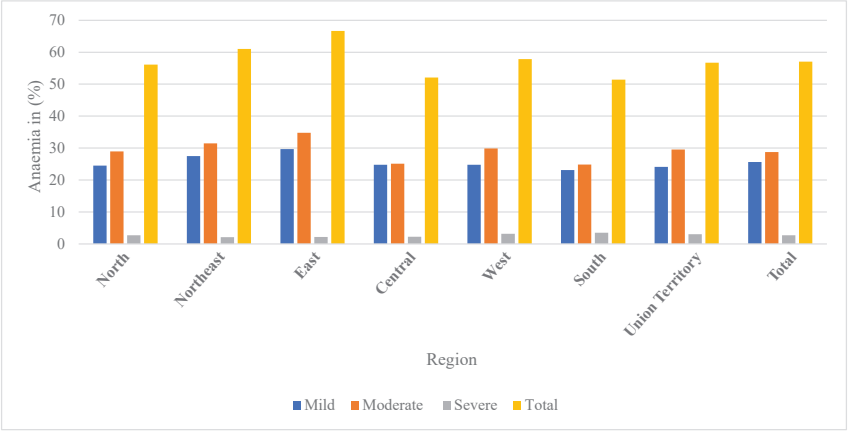
where $Having\ Anaemia_i$ is the probability of having anaemia for the $i$-th individual; $\alpha$ is the constant; $\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$, $\beta_5$, $\beta_6$, $\beta_7$, $\beta_8$, $\beta_9$, $\beta_{10}$, $\beta_{11}$, $\beta_{12}$, $\beta_{13}$, $\beta_{14}$, $\beta_{15}$ are the coefficients of explanatory variables, i.e., residence, antenatal

care (ANC) visits, diet, currently pregnancy status, region, wealth, age group, marital status, iron intake during pregnancy, total number of children, currently breastfeeding status, religion, presence of water for handwashing, use of soap, mensuration in last six weeks, family size, multidimensional poor; and $\mu_i$ is the error term.

## 4. Result and Findings

Figure 2 presents a region-wise analysis of anaemia prevalence among women of reproductive age. The figure reveals notable variations in the distribution of anaemia severity across different regions of India. East India exhibits the highest overall prevalence of anaemia (66.65%), with a particularly high proportion of women experiencing moderate anaemia (34.78%). In contrast, South India reports the lowest overall anaemia prevalence (51.43%), despite having the highest percentage of women with severe anaemia (3.49%). The North and West regions show similar overall anaemia prevalence (56.14% and 57.82% respectively), while Northeast India has a prevalence of 61.02%. Central India stands out with the lowest proportion of women experiencing moderate anaemia (25.08%), but a relatively higher percentage with severe anaemia (2.23%). The Union

**Figure 2**: Regional distribution of anaemia level among women of reproductive age in India (%)




Source: NFHS-5 (2019-2021) dataset

Territories demonstrate an anaemia prevalence (56.69%) comparable to the national average (57.05%). These findings highlight the existence of distinct regional patterns in the burden of anaemia among women of reproductive age in India.

Table 2 provides a regional breakdown of multidimensional poverty in India, presenting the headcount ratio, intensity, and overall MPI for each region indicates significant spatial variations in poverty trends. The East region is identified as the most impacted area, exhibiting the highest headcount ratio at 25.8% and an intensity of poverty at 42.6%, leading to a MPI of 0.110. The Central and Northeast regions exhibit headcount ratios of 22% and 20.6%, respectively, with associated MPI values of 0.093 and 0.086. The South and Union Territories demonstrate significantly lower poverty levels, with headcount ratios of 5.6% and 4.4%, and MPI values of 0.021 and 0.018, respectively.

A significant finding is the relative consistency in poverty intensity across regions, which ranges from 37.5% to 42.6%, despite considerable variations in headcount ratios. This indicates that although the percentage of impoverished individuals differs significantly across regions, the average severity of poverty among those classified as poor is relatively consistent. The national average MPI stands at 0.068, accompanied by a headcount ratio of 16.3% and an intensity of 41.7%, which obscures significant regional disparities.

Table 2 shows the necessity for geographically targeted interventions, especially in the East, Central, and Northeastern regions, where poverty is most severe. The uniform intensity scores across regions indicate that, although different areas may necessitate distinct intervention scales, the characteristics of poverty alleviation programmes should remain consistent across these regions. The success of South states and Union Territories in sustaining lower poverty levels may offer important policy insights for other regions. These insights are essential for formulating more effective, region-specific poverty reduction strategies while preserving a unified national framework for poverty alleviation.

**Table 2**: Regional headcount, intensity, and MPI

| Region | Headcount | Intensity | MPI |
|---|---|---|---|
| North | 12.1 | 40.5 | 0.049 |
| Northeast | 20.6 | 41.8 | 0.086 |
| East | 25.8 | 42.6 | 0.110 |
| Central | 22.0 | 42.3 | 0.093 |
| West | 10.6 | 40.6 | 0.043 |
| South | 5.6 | 37.5 | 0.021 |
| Union Territory | 4.4 | 40.9 | 0.018 |
| Total | 16.3 | 41.7 | 0.068 |

Source: NFHS-5 (2019-2021) dataset

Table 3 provides a comprehensive regional analysis of deprivation across various indicators of the MPI in India. The examination of multidimensional deprivation indicators throughout India's regions uncovers significant spatial disparities in multiple dimensions of poverty. The East consistently ranks as the most affected area, demonstrating the highest levels of deprivation across various indicators: years of education (13.06%), nutrition (19.10%), sanitation (19.80%), housing (22.64%), and access to cooking fuel (23.45%). This pattern indicates a significant concentration of multidimensional poverty in East India, necessitating immediate policy intervention.

The Northeast exhibits the second highest deprivation levels across multiple indicators, notably in housing (19.31%), cooking fuel (18.46%), and nutrition (14.96%). The region exhibits the highest deprivation rates in electricity access at 4.13% and drinking water at 6.30%, highlighting substantial infrastructure challenges. The Central region exhibits significant levels of deprivation, characterised by the highest rates of school attendance deprivation (6.66%) and child mortality (2.17%), indicating substantial deficiencies in educational access and healthcare services. The South region and Union Territories consistently exhibit lower deprivation levels across all indicators. Deprivation rates in the South vary, with electricity at 0.31% and nutrition at 3.92%. In contrast, the Union Territories exhibit lower rates, with electricity deprivation at only 0.11%. This significant regional variation underscores the effectiveness of development policies in these areas and offers potential policy insights for other regions.

The findings possess considerable implications for policy. They highlight the necessity for region-specific interventions, especially in the East and Northeast regions, where various deprivations converge. The variation in deprivation patterns across indicators indicates the need for dimension-specific policy approaches instead of universal solutions. The superior performance of the South and Union Territories may offer important insights for policy development in less advantaged areas. The analysis also highlights the necessity of addressing regional disparities via comprehensive policy interventions that simultaneously target various dimensions of deprivation, while considering region-specific challenges and contexts. This approach is essential for attaining more equitable development outcomes across the diverse regions of India.

**Table 3**: Region-wise deprivation in indicators of MPI (%)

| Indicator | North | Northeast | East | Central | West | South | Union Territories | Total |
|---|---|---|---|---|---|---|---|---|
| Years of education | 5.14 | 9.09 | 13.06 | 8.98 | 3.72 | 2.96 | 2.00 | 6.42 |
| School attendance | 2.48 | 3.34 | 5.31 | 6.66 | 2.11 | 0.76 | 1.46 | 3.16 |
| Child mortality | 1.16 | 1.31 | 1.94 | 2.17 | 0.92 | 0.52 | 0.48 | 1.21 |
| Nutrition | 9.16 | 14.96 | 19.10 | 16.46 | 8.29 | 3.92 | 3.19 | 10.73 |
| Electricity | 0.75 | 4.13 | 2.38 | 3.92 | 1.34 | 0.31 | 0.11 | 1.85 |
| Sanitation | 7.99 | 11.48 | 19.80 | 13.69 | 7.49 | 3.89 | 3.02 | 9.62 |
| Drinking water | 2.87 | 6.30 | 2.87 | 3.38 | 2.61 | 1.04 | 1.08 | 2.88 |
| Housing | 9.13 | 19.31 | 22.64 | 19.10 | 7.42 | 3.36 | 2.61 | 11.94 |
| Cooking fuel | 10.60 | 18.46 | 23.45 | 18.60 | 8.13 | 3.45 | 2.28 | 12.14 |
| Assets | 3.87 | 9.53 | 9.31 | 5.76 | 4.62 | 2.06 | 1.44 | 5.23 |

Table 4 provides an analysis of anaemia prevalence among women of reproductive age across various regions and socio-demographic factors in India. The analysis indicates notable differences in anaemia prevalence across various socioeconomic and demographic factors. A clear socio-economic gradient is observed, with multidimensionally poor households exhibiting higher anaemia rates (62.97%) than non-poor households (55.86%). The disparity is notably evident in the East, with 68.78% of women from impoverished households affected by anaemia, in contrast to 65.87% from non-impoverished households. Rural-urban disparities are significant, with rural areas exhibiting a higher prevalence of anaemia

(58.51%) than urban areas (53.81%). The disparity is particularly evident in the Union Territories, with rural anaemia rates at 66.97%, in contrast to 51.97% in urban regions. The analysis of wealth quintiles highlights a socioeconomic gradient, revealing that the poorest quintile exhibits significantly higher anaemia rates (63.68%) than the richest quintile (50.98%).

Hygiene practices are significantly associated with the prevalence of anaemia. The availability of handwashing facilities and the use of soap are associated with reduced anaemia rates, as evidenced by a 5.39 percentage point lower prevalence among soap users compared to non-users (55.20% vs. 60.59%). This pattern is observed consistently across regions, indicating the significance of hygiene interventions in the prevention of anaemia. Reproductive health factors exhibit notable patterns. Pregnant women exhibit lower anaemia rates (52.15%) than non-pregnant women (57.22%), potentially indicating the effects of targeted antenatal care. Breastfeeding women exhibit a higher prevalence of anaemia (60.50%) than non-breastfeeding women (56.44%), indicating elevated nutritional requirements during lactation.

Regional and cultural variations are significant. The East consistently exhibits the highest burden of anaemia across most categories, whereas the South typically shows a lower prevalence. Disparities based on religion and caste are apparent, with Scheduled Tribes (ST) recording notably elevated anaemia rates (64.6%) in comparison to other social groups.

**Table 4**: Socio-economic profile of women of reproductive age with anaemia (%)

| Factors | North | Northeast | East | Central | West | South | Union Territories | Total |
|---|---|---|---|---|---|---|---|---|
| *Multidimensional poor* | | | | | | | | |
| No | 55.62 | 59.99 | 65.87 | 50.79 | 56.70 | 50.89 | 56.27 | 55.86 |
| Yes | 60.48 | 65.19 | 68.78 | 56.66 | 66.91 | 60.43 | 64.93 | 62.97 |
| *Type of residence* | | | | | | | | |
| Urban | 53.84 | 56.03 | 64.25 | 50.84 | 54.81 | 48.71 | 51.97 | 53.81 |
| Rural | 57.05 | 62.20 | 67.40 | 52.54 | 60.01 | 53.28 | 66.97 | 58.51 |
| *Wealth* | | | | | | | | |
| Poorest | 59.93 | 64.00 | 69.46 | 55.71 | 67.07 | 59.56 | 70.93 | 63.68 |
| Poorer | 58.02 | 60.98 | 66.76 | 52.18 | 61.92 | 57.36 | 65.88 | 59.5 |
| Middle | 57.18 | 59.75 | 64.70 | 52.24 | 58.16 | 53.62 | 61.25 | 56.88 |
| Richer | 56.20 | 56.71 | 63.98 | 50.41 | 56.38 | 50.07 | 59.12 | 54.38 |
| Richest | 54.02 | 56.09 | 61.18 | 48.52 | 53.34 | 44.89 | 51.52 | 50.98 |

| Factors | North | Northeast | East | Central | West | South | Union Territories | Total |
|---|---|---|---|---|---|---|---|---|
| *Presence of water for handwash* | | | | | | | | |
| No | 55.80 | 62.48 | 69.87 | 55.88 | 62.10 | 57.22 | 61.85 | 63.25 |
| Yes | 56.14 | 60.92 | 65.64 | 51.84 | 57.34 | 51.11 | 56.36 | 56.30 |
| *Use of soap* | | | | | | | | |
| No | 57.15 | 63.77 | 68.09 | 53.73 | 61.24 | 55.73 | 59.24 | 60.59 |
| Yes | 55.83 | 58.93 | 65.24 | 51.34 | 56.56 | 49.74 | 56.28 | 55.20 |
| *Dietary habits* | | | | | | | | |
| Non-vegetarian | 55.53 | 60.94 | 66.76 | 52.02 | 55.67 | 51.08 | 57.60 | 57.61 |
| Vegetarian | 56.30 | 63.12 | 66.15 | 52.22 | 59.76 | 53.03 | 55.27 | 56.08 |
| *Iron pill intake during pregnancy* | | | | | | | | |
| No | 59.64 | 60.27 | 67.42 | 57.04 | 57.18 | 53.57 | 59.09 | 60.58 |
| Yes | 58.19 | 61.81 | 68.92 | 55.97 | 58.78 | 49.68 | 57.70 | 58.99 |
| *Currently pregnant* | | | | | | | | |
| No | 56.44 | 61.51 | 66.89 | 52.30 | 57.92 | 51.58 | 57.10 | 57.22 |
| Yes | 48.89 | 50.39 | 62.06 | 47.92 | 51.64 | 46.95 | 44.25 | 52.15 |
| *Currently breastfeeding* | | | | | | | | |
| No | 55.77 | 60.45 | 65.88 | 51.13 | 57.56 | 51.83 | 56.23 | 56.44 |
| Yes | 58.79 | 63.71 | 70.02 | 57.15 | 58.97 | 47.78 | 59.21 | 60.50 |
| *Number of ANC visits* | | | | | | | | |
| No | 57.01 | 56.71 | 68.49 | 57.32 | 60.68 | 49.14 | 61.34 | 62.42 |
| Up to 4 | 60.15 | 60.93 | 68.35 | 56.32 | 58.58 | 52.26 | 60.93 | 60.32 |
| More than 4 | 57.42 | 62.82 | 68.86 | 55.67 | 58.34 | 49.62 | 57.14 | 58.17 |
| *Mensurated in last six weeks* | | | | | | | | |
| No | 50.99 | 60.43 | 66.63 | 50.28 | 52.93 | 46.82 | 50.71 | 54.59 |
| Yes | 57.03 | 61.18 | 66.68 | 52.51 | 58.74 | 52.56 | 57.64 | 57.58 |
| *Religion* | | | | | | | | |
| Hindu | 56.02 | 67.04 | 67.00 | 52.35 | 58.70 | 52.38 | 53.96 | 57.40 |
| Muslim | 53.04 | 59.23 | 64.79 | 50.26 | 52.00 | 45.01 | 61.88 | 55.61 |
| Christian | 56.08 | 45.49 | 70.68 | 57.72 | 48.58 | 49.82 | 57.46 | 51.56 |
| Others | 58.63 | 42.66 | 68.20 | 54.12 | 56.23 | 46.26 | 57.58 | 57.87 |
| *Caste* | | | | | | | | |
| SC | 59.57 | 63.87 | 69.40 | 51.60 | 59.49 | 55.01 | 56.75 | 59.02 |
| ST | 61.06 | 53.85 | 72.84 | 64.57 | 68.05 | 53.89 | 62.82 | 64.60 |
| OBC | 54.15 | 69.06 | 63.60 | 50.62 | 58.19 | 50.52 | 52.94 | 54.67 |
| General | 53.73 | 59.56 | 64.93 | 50.87 | 52.23 | 49.00 | 56.39 | 55.08 |

Source: NFHS-5 (2019-2021) dataset

Table 5 presents the results of a logistic regression analysis examining the factors associated with anaemia among women of reproductive age. The analysis reveals several significant predictors of anaemia prevalence. In terms of socio-economic factors, women residing in multidimensionally poor households exhibit a 1.14 times higher likelihood of having anaemia compared to those in non-poor households, underscoring the influence of socio-economic deprivation on anaemia risk. Women from rural areas are 1.05 times more likely to experience anaemia than their urban counterparts, highlighting the role of geographical context and potentially limited access to healthcare and nutrition in rural settings. A clear gradient emerges across wealth quintiles, with women from the poorest households facing the highest anaemia risk. Compared to the poorest, those in the richer and richest categories are less likely to have anaemia by a factor of 0.88 and 0.76 respectively, emphasising the protective effect of improved economic well-being.

In terms of hygiene and sanitation factors, the presence of water for handwashing is associated with a slight but significant decrease (0.99 times) in anaemia likelihood, suggesting a potential role of improved hygiene practices in reducing anaemia risk. Similarly, using soap for handwashing is associated with a marginal decrease (0.99 times) in anaemia likelihood, further supporting the importance of hygiene. For dietary practices, women consuming a vegetarian diet are 1.07 times more likely to have anaemia compared to those with a non-vegetarian diet, highlighting the potential influence of dietary iron intake on anaemia status. Interestingly, where reproductive health factors are concerned, women taking iron pills during pregnancy was not significantly associated with anaemia status in this model. Currently pregnant women are 0.87 times less likely to have anaemia compared to non-pregnant women, possibly reflecting increased healthcare access and nutritional interventions during pregnancy. Breastfeeding is associated with a slightly increased likelihood (1.03 times) of anaemia, potentially due to increased nutritional demands during lactation. Women attending at least one ANC visit are more likely to have anaemia compared to those with no visits, with the likelihood increasing slightly for those attending more than four visits. This unexpected finding might reflect that woman with identified health risks, including anaemia, are encouraged to attend more ANC visits. Women who had their haemoglobin measured within the last six weeks are less likely (0.98 times) to have anaemia, likely

reflecting the impact of diagnosis and subsequent treatment or interventions. In terms of demographic factors, women from larger families (more than six members) are 1.03 times more likely to have anaemia compared to those in smaller families, suggesting potential resource constraints within larger households.

Significant regional variations in anaemia prevalence are observed. Compared to the North, women from the East have a 1.43 times higher likelihood of anaemia, while those from the South are 0.79 times less likely. These differences likely reflect variations in dietary practices, socio-economic conditions, and healthcare access across regions. Religious affiliation also plays a role, with Muslim and Christian women being less likely to have anaemia compared to Hindu women (0.85 and 0.70 times, respectively). This could be linked to cultural factors influencing dietary choices and health-seeking behaviours. Belonging to ST is associated with a higher likelihood of anaemia (1.22 times) compared to Scheduled Castes (SC), highlighting the persistent vulnerability of ST communities. Conversely, women from Other Backward Classes (OBC) and General Castes (GC) have a lower likelihood of anaemia compared to SC women.

Overall, the logistic regression analysis underscores the multifactorial nature of anaemia among women of reproductive age in India. Socio-economic factors, hygiene and sanitation practices, dietary habits, pregnancy and reproductive health factors, and demographic characteristics all contribute to the risk of anaemia.

**Table 5**: Logistic regression analysis of women with anaemia

| **Have Anaemia** | **Coefficient** | **Odds ratio** | **Sig** |
|---|---|---|---|
| *Multidimensional poor households* | | | |
| No | Reference | | |
| Yes | 0.127 | 1.135 | *** |
| *Type of residence* | | | |
| Urban | Reference | | |
| Rural | 0.046 | 1.047 | *** |
| *Wealth* | | | |
| Poorest | Reference | | |
| Poorer | -0.004 | 0.995 | *** |
| Middle | -0.047 | 0.953 | *** |
| Richer | -0.131 | 0.876 | *** |
| Richest | -0.273 | 0.761 | *** |

| Have Anaemia | Coefficient | Odds ratio | Sig |
|---|---|---|---|
| *Presence of water for handwash* | | | |
| No | Reference | | |
| Yes | -0.014 | 0.985 | *** |
| *Use of soap* | | | |
| No | Reference | | |
| Yes | 0.017 | 1.017 | *** |
| *Dietary habits* | | | |
| Non-vegetarian | Reference | | |
| Vegetarian | 0.063 | 1.065 | *** |
| *Iron pill intake during pregnancy* | | | |
| No | Reference | | |
| Yes | -0.003 | 0.996 | *** |
| *Currently pregnant* | | | |
| No | Reference | | |
| Yes | -0.137 | 0.871 | *** |
| *Currently breastfeeding* | | | |
| No | Reference | | |
| Yes | 0.028 | 1.028 | *** |
| *Number of ANC Visits* | | | |
| No ANC visits | Reference | | |
| Up to 4 ANC visits | 0.041 | 1.042 | *** |
| More than 4 ANC | 0.038 | 1.039 | *** |
| *Mensurated in last six weeks* | | | |
| No | Reference | | |
| Yes | -0.015 | 0.984 | *** |
| *Family size* | | | |
| Up to six members | Reference | | |
| More than six members | 0.032 | 1.033 | *** |
| *Region* | | | |
| North | Reference | | |
| Northeast | 0.109 | 1.116 | *** |
| East | 0.358 | 1.430 | *** |
| Central | -0.141 | 0.868 | *** |
| West | 0.045 | 1.046 | *** |
| South | -0.235 | 0.790 | *** |
| Union Territories | 0.139 | 1.149 | *** |

| **Have Anaemia** | **Coefficient** | **Odds ratio** | **Sig** |
|---|---|---|---|
| *Religion* | | | |
| Hindu | Reference | | |
| Muslim | -0.160 | 0.851 | *** |
| Christian | -0.353 | 0.701 | *** |
| Others | 0.013 | 1.013 | *** |
| *Caste* | | | |
| SC | Reference | | |
| ST | 0.201 | 1.223 | *** |
| OBC | -0.118 | 0.888 | *** |
| General | -0.123 | 0.884 | *** |
| Constant | 0.388 | 1.474 | *** |
| SD dependent variable | 0.493 | | |
| Number of observations | 146746 | | |
| Prob > $chi^2$ | 0 | | |
| Bayesian criterion (BIC) | 1.87E+11 | | |
| Mean dependent var | 0.416 | | |
| Pseudo $R^2$ | 0.019 | | |
| $Chi^2$ | 3.57E+09 | | |
| Akaike criterion (AIC) | 1.87E+11 | | |

Source: NFHS-5 (2019-2021) dataset.
Note: *** p < 0.01, ** p < 0.05, * p < 0.1

## 5. Discussion

This comprehensive study on anaemia among Indian women of reproductive age corroborates and extends existing literature, revealing a complex interplay of regional, socio-economic, nutritional, and health-related factors. The findings underscore the multifaceted nature of anaemia in India and highlight the need for nuanced, context-specific interventions. The study reveals significant regional variations in anaemia prevalence across India. East India, with a prevalence rate of 66.65%, mirrors severe cases observed in Central and West Africa, where rates exceed 40% (WHO, 2024). This stark regional disparity emphasises the necessity for tailored, region-specific interventions that address unique local challenges and socio-cultural contexts.

Socio-economic factors emerge as critical determinants of anaemia prevalence. Consistent with studies from Malawi (Adamu et al., 2017) and Eastern Africa (Teshale et al., 2020), our research indicates that rural women are 1.05 times more likely to experience anaemia compared to their urban counterparts. Moreover, women from multidimensionally poor households exhibit a 1.14 times higher likelihood of anaemia, underscoring the profound impact of socio-economic deprivation on health outcomes. These findings align with the global trend of health inequities and stress the need for interventions that address broader social determinants of health. Nutritional deficiencies, particularly in iron, vitamin B12, and folate, play a pivotal role in anaemia prevalence. Our study found that women adhering to vegetarian diets are 1.07 times more likely to have anaemia, highlighting the importance of dietary iron intake. This finding is consistent with research from Pakistan (Qadir et al., 2022) and Nepal (Sunuwar et al., 2020), supporting the need for targeted nutritional interventions and dietary education programmes. The development of culturally appropriate, iron-rich dietary guidelines for vegetarian populations could be a crucial step in addressing this issue.

The study reveals intriguing patterns regarding reproductive health and anaemia. Contrary to expectations, currently pregnant women are 0.87 times less likely to have anaemia, possibly due to increased healthcare access and nutritional support during pregnancy. This finding suggests that antenatal care programmes may be effective in managing anaemia risk. However, breastfeeding women show a slightly increased risk of anaemia (1.03 times), reflecting the nutritional demands of lactation. These results align with previous studies highlighting the complex relationship between reproductive health and anaemia (Mog & Ghosh, 2021; Talin et al., 2023). The study underscores the importance of hygiene practices in anaemia prevention, as discussed by Jacob and Saggu (2024). Access to water for handwashing and soap use is associated with a slight but significant decrease in anaemia likelihood. This finding emphasises the interconnectedness of various health determinants and suggests that comprehensive public health strategies should include improved sanitation and hygiene practices.

The pronounced regional disparities in anaemia prevalence, as highlighted in our study, necessitate context-specific interventions. High anaemia rates in regions like Uttar Pradesh (Sharma et al., 2024) reflect differences in dietary practices, socio-economic conditions, and healthcare access. These findings call for tailored public health strategies that consider

regional specificities in culture, diet, and healthcare infrastructure. While this study provides valuable insights, its cross-sectional nature limits causal inferences. The relationship between contraceptive methods and anaemia, as explored by Adhikary et al. (2024), warrants further investigation. Interestingly, our study does not find a significant link between iron pill intake during pregnancy and anaemia status, suggesting that other factors may be more influential or that the effectiveness of current iron supplementation programmes needs reassessment.

## 6. Conclusion

This study underscores the intricate, multifaceted nature of anaemia in Indian women of reproductive age. It promotes comprehensive, context-specific therapies that tackle not only nutritional deficits but also larger socio-economic, cultural, and health system problems. This comprehensive analysis of anaemia among women of reproductive age in India yields several critical policy recommendations that warrant immediate attention. First, the stark regional disparities, particularly in East India, necessitate geographically differentiated interventions that account for local socio-cultural contexts and healthcare infrastructure capabilities. The strong association between multidimensional poverty and anaemia suggests the need for integrated poverty reduction and health improvement strategies, potentially through enhanced convergence between existing schemes like the National Rural Livelihood Mission and AMB.

Given the significant rural-urban disparities, strengthening rural healthcare infrastructure and service delivery is crucial. This includes expanding the network of rural health centres and deploying mobile health units to ensure consistent service delivery in remote areas. The findings regarding dietary practices suggest the need for nutrition-sensitive policies, particularly for vegetarian women who show higher anaemia risk. These could include promoting iron-fortified foods and developing targeted nutritional interventions. The relationship between hygiene practices and anaemia calls for strengthening the integration of water, sanitation, and hygiene (WASH) initiatives with anaemia prevention programmes. Additionally, the quality and coverage of reproductive health services need enhancement, with particular attention to extended nutritional support during the postpartum period. The significant disparities across social groups,

especially among ST, necessitate culturally sensitive interventions that address community-specific challenges.

To improve programme effectiveness, we recommend establishing robust monitoring and evaluation systems and developing a comprehensive national strategy that coordinates actions across different ministries. These recommendations require sustained political commitment, adequate resource allocation, and effective stakeholder coordination at all governmental levels. Future research should focus on longitudinal studies to clarify causal pathways and evaluate intervention impacts.

## Conflicts of Interest

There is no potential conflict of interest.

## Funding

No funding is involved with this research.

## Data Availability

Data used for this study is available from the International Institute for Population Sciences (IIPS).

## CRediT author statement

**Pushpendra Kumar Singh**: Conceptualization. Pushpendra Kumar Singh: Design of methodology.
**Pushpendra Kumar Singh**: Data collection/ curation. Pushpendra Kumar Singh: Formal analysis.
**Sanatan Nayak**: Writing- Original draft preparation and editing.

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