ORIGINAL RESEARCH ARTICLE

# Decomposition Analysis of Anemia Among Women of Reproductive Age in Northeast India: Evidence from NFHS-4 and NFHS-5

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## ABSTRACT

**Background:** Anemia, characterized by low red blood cell and haemoglobin levels, affects 1.62 billion people globally. It is a major public health concern among reproductive-age women in India, particularly in Northeast regions, where prevalence remains high. The study aims to analyze trends in anemia among reproductive-age women in Northeast India, drawing on data from the NFHS. By employing decomposition analysis, the research seeks to evaluate the extent to which socioeconomic, demographic, and dietary factors have contributed to changes in anemia prevalence over time.

**Methodology:** The study used descriptive statistical analysis to examine anemia trends and a logit-based multivariate decomposition analysis to quantify the contributions of compositional (endowment) and behavioural (coefficient) factors. Statistical significance was set at $p<0.05$.

**Findings:** Anemia prevalence among women in Northeast India rose from 38.7% (NFHS-4) to 50.1% (NFHS-5), with significant variations across demographic, socioeconomic, and dietary factors. Decomposition analysis showed 18.9% of the increase was due to compositional shifts, notably wealth index and residence, while 81.1% was attributed to behavioural factors like diet and socioeconomic status. Consumption of vegetables, fish, and milk significantly influenced anemia trends.

**Conclusions:** Addressing socioeconomic disparities and promoting balanced diets through targeted interventions are essential to reducing anemia prevalence in Northeast India.

**Keywords:** Anemia, Reproductive-Age, Decomposition Analysis, Northeast India

## ARTICLE INFO

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# Introduction

Anemia is a significant global public health concern, affecting approximately 1.62 billion individuals,[1] and is particularly widespread among women of reproductive age (15–49 years) in both developed and developing countries. The condition is primarily caused by nutritional deficiencies (iron, folate, vitamins), infections (helminthiasis, malaria), and limited access to iron supplements.[2,3] Its prevalence is more severe in developing nations due to factors such as iron deficiency, low female education, poor nutritional awareness, family history, inadequate healthcare access, and economic hardship.[4,5] A key challenge under the Millennium Development Goals (MDGs) and now the Sustainable Development Goals (SDGs) is to reduce anemia prevalence among women.[6-8] According to the World Health Organization (WHO), over 30% of non-pregnant women are anemic globally, especially in South Asia and sub-Saharan Africa.[9,10]

In India, anemia among women remains a critical concern, with gender norms significantly impacting prevalence. Women from Scheduled Castes, Scheduled Tribes, and Other Backward Castes often face restricted access to health interventions and nutrition.[11,12] The NFHS-5 (2019–21) data show a rise in anemia compared to NFHS-4 (2015–16), with socioeconomic and geographic disparities increasing risks, particularly among adolescents and children.[13-15] Additionally, gender-related barriers continue to limit women's access to iron supplements and iron-rich foods.[16]

In Northeast India, anemia prevalence remains high, especially among non-pregnant women, with iron deficiency anemia being the most common.[17,18] Studies show 55–70% prevalence in many northeastern states, with regional disparities playing a key role.[19-24] Despite the high burden, limited research explores the underlying causes or persistent trends of anemia in this population. To bridge this research gap, the current study analyzes data from NFHS-4 and NFHS-5, utilizing decomposition analysis to explore how socioeconomic, demographic, and dietary factors have influenced changes in anemia prevalence among women aged 15 to 49 in Northeast India.

# Methodology

**Data source:** The present study utilizes the data from the two rounds of the National Family Health Survey (NFHS), carried out by the Ministry of Health and Family Welfare of the Government of India, with the International Institute for Population Science acting as the nodal organization.[31,32]

**Study area and population:** The present study utilizes secondary data on anemia from two rounds of the National Family Health Survey (NFHS), conducted by the Ministry of Health and Family Welfare, Government of India, with the International Institute for Population Sciences (IIPS) as the nodal agency. The analysis draws on data from NFHS-4 (2015–16) and NFHS-5 (2019–21) pertaining to the eight northeastern states of India—Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, and Sikkim.

**Inclusion Criteria:** The study includes only female respondents aged 15–49 years, representing women of reproductive age residing in the northeastern region of India. The final sample consisted of 96,352 women in NFHS-4 and 100,435 women in NFHS-5.

**Exclusion Criteria:** The study excluded males and females below 15 years and above 49 years of age. Individuals residing outside the northeastern states of India, as well as visitors or non-usual residents of the region, were not considered. Additionally, records with missing, incomplete, or invalid hemoglobin data were excluded from the analysis.

**Variable measurement:** In the study, the dependent variable (anemia) was categorized dichotomously: "1" for 'anemic', which includes all women of reproductive age (15–49 years) falling into the mild, moderate, or severe anemia categories, and "0" for 'not anemic', referring to women with hemoglobin levels ≥11 g/dL, applicable to both pregnant and non-pregnant women, in accordance with WHO and NFHS classification.

The independent variables analysed in this study included socio-economic characteristics such as: place of residence (1=urban, 2=rural), education level (1=no education, 2=primary, 3=secondary, 4=higher), religion (1=Hindu, 2=Muslim, 3=Christian, 4=other), ethnicity (1=caste, 2=tribe, 3=no caste/tribe, 4=don't know), wealth index (1=poorest, 2=poorer, 3=middle, 4=richer, 5=richest), number of children born (1=no child, 2=one child, 3=two children, 4=three children, 5=four or more children), currently pregnant (1=no or unsure, 2=yes); demographic characteristics considered were: age (1=15-19, 2=20-24, 3=25-29, 4=30-34, 5=35-39, 6=40-44, 7=45-49), marital status (1=never in union, 2=married, 3=widowed/divorced/separated); diet characteristics included: consumption of milk or curd (1=never, 2=daily, 3=weekly, 4=occasionally), pulses/beans (1=never, 2=daily, 3=weekly, 4=occasionally), vegetables (1=never, 2=daily, 3=weekly, 4=occasionally), fruits (1=never, 2=daily, 3=weekly, 4=occasionally), eggs (1=never, 2=daily, 3=weekly, 4=occasionally), fish (1=never, 2=daily, 3=weekly, 4=occasionally), chicken or meat (1=never, 2=daily, 3=weekly, 4=occasionally), fried foods (1=never, 2=daily, 3=weekly, 4=occasionally), aerated drinks (1=never, 2=daily, 3=weekly, 4=occasionally).

**Data collection procedure:** Since the study was based on the NFHS, data were obtained from the official database of the DHS program at https://dhsprogram.com. After requesting permission online and explaining the purpose of the study, permission was granted.[31,32]

**Data quality assurance:** Data from the NFHS-4 and NFHS-5 were accessed from the DHS official database and were merged together by using the Stata command "append" after extracting the relevant variables for trend and decomposition analysis. STATA version 14 software was used to clean, compute, recode, and handle the missed data.

**Trend and Multivariate decomposition analysis:** The trend period was divided into two phases—NFHS-4 (2015–16) and NFHS-5 (2019–21)—to examine changes in anemia prevalence among women of reproductive age (15–49 years) in Northeast India. Binary logistic regression was used to evaluate shifts in anemia levels across the two survey rounds. Additionally, descriptive analysis, stratified by selected socio-economic, demographic, and dietary characteristics, was conducted to identify variations across different population subgroups in each phase.

To further explore the changing patterns of anemia, a logit-based multivariate decomposition analysis for a non-linear response model was conducted. This approach quantified the extent to which the observed change in anemia prevalence between NFHS-4 and NFHS-5 was attributable to two components: difference due to population characteristics (endowments) and difference due to the effects of those characteristics (coefficients). The analysis relied on outputs from logistic regression models to separate the influence of structural changes in the population from shifts in how these factors impacted anemia outcomes. The technique follows the methodology outlined by Powers et al. (Stata Journal, 2011).[25,26]

A p-value of less than 0.05 was considered statistically significant for both the overall decomposition and the individual contributions of the endowment and coefficient components. This technique is especially effective for non-linear models in distinguishing whether differences over time are due to changes in population composition or behavioural/contextual changes.

In this study, the decomposition analysis offered critical insights into the key drivers of change in anemia prevalence among reproductive-age women in Northeast India, helping to determine whether observed shifts were primarily due to structural changes in the population or evolving effects of specific variables.

$$Y = F\left(\frac{e^{X\beta}}{1+e^{X\beta}}\right) + \varepsilon$$

$$Ya - Yb = F\left(\frac{e^{Xa\beta a}}{1+e^{Xa\beta a}}\right) - F\left(\frac{e^{Xb\beta b}}{1+e^{Xb\beta b}}\right) + \varepsilon$$

$$\Delta Y = \underbrace{\left[F\left(\frac{e^{Xa\beta a}}{1+e^{Xa\beta a}}\right) - F\left(\frac{e^{Xb\beta a}}{1+e^{Xb\beta a}}\right)\right]}_{E} + \underbrace{\left[F\left(\frac{e^{Xb\beta a}}{1+e^{Xb\beta a}}\right) - F\left(\frac{e^{Xb\beta b}}{1+e^{Xb\beta b}}\right)\right]}_{C} + \varepsilon$$

Where: Y is the dependent variable, X is the independent variable, β is the coefficient and F is differential logistic function of X $\left(\frac{e^{X\beta}}{1+e^{X\beta}}\right)$ and Y. Hence, the result focused on how anemia responded to population composition and their behaviour and how these factors shape it across different surveys at different times.

Here: The E component represents the part of the differential attributable to differences in characteristics or endowments (characteristics effects) of the population, and the C component represents the differential attributable to differences in coefficients or effects of the explanatory variables (coefficients effects). After that, E and C were separated into portions in order to estimate the contribution of each factor to each component (detailed decomposition). This analysis was done through the *mvdcmp* command.[26]

**Ethical considerations:** As the study was based on secondary data, accessed from the MEASURE DHS program, this study did not require ethical approval and participant consent.

## Results

**Trends of anemia:** Table 1: Anemia prevalence increased across all age groups between NFHS-4 and NFHS-5, with the highest rise observed among adolescent women aged 15–19 years (15.9%) and the lowest among women aged 40–44 years (9.1%).

Socioeconomic disparities were evident, with the poorest wealth index group witnessing a 9.2% rise in anemia prevalence. The increase was slightly more pronounced in rural areas (10.9%) compared to urban areas (10.5%). Among non-pregnant women, the prevalence rose by 11.8%, whereas pregnant women experienced a smaller increase of 3.9%. Among religious groups, Muslim women showed the highest increase (17.5%), closely followed by Hindu women (17.3%). Although women categorized under "unknown ethnicity" recorded the highest anemia rates in both survey rounds, the greatest increase was observed among women belonging to scheduled castes (17.7%).

Dietary patterns also influenced the trends. Women who consumed milk or curd daily had a 9.2% increase in anemia prevalence, while those who occasionally consumed green vegetables showed a 9.0% rise. A substantial increase (15.8%) was also seen among women who reported eating fish.

**Decomposition analysis:** Table 2: The decomposition analysis model has been taken into account to show how the differences in the characteristics (compositional factors) and the differences due to the effect of these characteristics contribute to the overall change in anemia prevalence.

The results of the decomposition analysis are presented in (Table 2). The table shows the percentage contribution of each factor to the prevalence of anemia gap between NFHS-4 and NFHS-5 reproductive-aged women population in Northeast India.

**Analysis of Differences Due to Characteristics:** Only 18.9% of the overall change in anemia prevalence was due to differences in characteristics, highlighting the role of demographic, socioeconomic, and dietary composition in this shift.

Among compositional factors, socio-demographic variables such as the wealth index (+9.85%) had the most significant positive impact, followed by place of residence (+2.47%), ethnicity (+0.61%), religion (+0.45%), current pregnancy status (+0.01%) and marital status (+0.07%).

**Table 1: Trends in Anemia Prevalence Among Women of Reproductive Age (15–49 Years) in Northeast India Based on NFHS-4 (2015–16) and NFHS-5 (2019–21)**

| Variables | NFHS-4 (2015-16) | NFHS-5 (2019-21) | Changes (%) | Variables | NFHS-4 (2015-16) | NFHS-5 (2019-21) | Changes (%) |
|---|---|---|---|---|---|---|---|
| **Age in years** | | | | **Frequency takes milk or curd** | | | |
| 15-19 | 37.4 | 53.3 | 15.9 | Never | 37.5 | 47.3 | 9.8 |
| 20-24 | 38.7 | 50.7 | 12 | Daily | 36.9 | 46.1 | 9.2 |
| 25-29 | 38.7 | 48.9 | 10.2 | Weekly | 41.2 | 52.1 | 10.9 |
| 30-34 | 38.2 | 48.8 | 10.6 | Occasionally | 38.6 | 51.9 | 13.3 |
| 35-39 | 39.2 | 50 | 10.8 | **Frequency eats pulses/beans** | | | |
| 40-44 | 40.3 | 49.4 | 9.1 | Never | 42.7 | 50.2 | 7.5 |
| 45-49 | 39.4 | 49.6 | 10.2 | Daily | 43.6 | 56.7 | 13.1 |
| **Type of place of residence** | | | | Weekly | 37.2 | 46.9 | 9.7 |
| Urban | 33.1 | 43.6 | 10.5 | Occasionally | 34.1 | 43.2 | 9.1 |
| Rural | 40.8 | 51.7 | 10.9 | **Frequency eats vegetables** | | | |
| **Highest educational level** | | | | Never | 43.9 | 49.3 | 5.4 |
| No education | 44.5 | 53.9 | 9.4 | Daily | 38.1 | 47.1 | 9 |
| Primary | 41.8 | 52.6 | 10.8 | Weekly | 39.9 | 53.7 | 13.8 |
| Secondary | 37.2 | 49.8 | 12.6 | Occasionally | 40.2 | 55 | 14.8 |
| Higher | 32.2 | 43.2 | 11 | **Frequency eats fruits** | | | |
| **Religion** | | | | Never | 42.6 | 55.5 | 12.9 |
| Hindu | 44.3 | 61.6 | 17.3 | Daily | 37.7 | 47 | 9.3 |
| Muslim | 40.6 | 58.1 | 17.5 | Weekly | 38.6 | 50.2 | 11.6 |
| Christian | 33.8 | 39.3 | 5.5 | Occasionally | 38.9 | 50.5 | 11.6 |
| Other | 36.7 | 40.9 | 4.2 | **Frequency eats eggs** | | | |
| **Ethnicity** | | | | Never | 40.2 | 53.1 | 12.9 |
| Caste | 41.8 | 59.5 | 17.7 | Daily | 38.4 | 49.4 | 11 |
| Tribe | 35.8 | 41.8 | 6 | Weekly | 39.6 | 52 | 12.4 |
| No caste/ tribe | 42.7 | 59.4 | 16.7 | Occasionally | 37.5 | 47.1 | 9.6 |
| Don't know | 51 | 65.7 | 14.7 | **Frequency eats fish** | | | |
| **Wealth index combined** | | | | Never | 39 | 47 | 8 |
| Poorest | 46.4 | 55.6 | 9.2 | Daily | 38.4 | 54.2 | 15.8 |
| Poorer | 41.5 | 50.5 | 9 | Weekly | 41.3 | 54.1 | 12.8 |
| Middle | 37.7 | 47.7 | 10 | Occasionally | 35.6 | 43.3 | 7.7 |
| Richer | 34.5 | 44.2 | 9.7 | **Frequency eats chicken/meat** | | | |
| Richest | 31.3 | 42.1 | 10.8 | Never | 40.7 | 55.5 | 14.8 |
| **Total no of children born** | | | | Daily | 34.1 | 46.1 | 12 |
| No child | 35.4 | 48.3 | 12.9 | Weekly | 38.6 | 50.3 | 11.7 |
| One child | 40.2 | 52.1 | 11.9 | Occasionally | 39 | 50 | 11 |
| Two children | 40.8 | 52.6 | 11.8 | **Frequency eats fried food** | | | |
| Three children | 39.6 | 48.6 | 9 | Never | 40.3 | 51.9 | 11.6 |
| Four or more child | 40.7 | 49.7 | 9 | Daily | 38.7 | 54.6 | 15.9 |
| **Currently pregnant** | | | | Weekly | 39.1 | 49.2 | 10.1 |
| No or unsure | 38.8 | 50.6 | 11.8 | Occasionally | 38.2 | 49.5 | 11.3 |
| Yes | 37.2 | 41.1 | 3.9 | **Frequency eats aerated drinks** | | | |
| **Current marital status** | | | | Never | 41.3 | 49.9 | 8.6 |
| Never in union | 34.8 | 48 | 13.2 | Daily | 41 | 53.7 | 12.7 |
| Married | 40.2 | 50.9 | 10.7 | Weekly | 37.6 | 48.8 | 11.2 |
| Widowed/Divorced/ Separated | 40.6 | 51.1 | 10.5 | Occasionally | 37.9 | 47.9 | 10 |
| | | | | TOTAL | 38.7 | 50.1 | 11.4 |

Abbreviation: NFHS, National Family Health Survey; Values are in Percentage

**Table 2: Detailed Decomposition Analysis of Changes in Anemia Prevalence Among Women of Reproductive Age (15–49 Years) in Northeast India Between NFHS-4 (2015–16) and NFHS-5 (2019–21)**

| Variables | Difference due to characteristics(E) | | | Difference due to coefficient(C) | | |
|---|---|---|---|---|---|---|
| | Coefficient | P-value | Percent | Coefficient | P-value | Percent |
| **Age in years** | | | **-0.46** | | | **-32.13** |
| 15-19 | | Reference | | | Reference | |
| 20-24 | -0.00007 | 0.189 | 0.06 | 0.00461 | 0.001 | -4.05 |
| 25-29 | 0.00003 | 0.000 | -0.03 | 0.00702 | 0.000 | -6.16 |
| 30-34 | 0.00001 | 0.000 | -0.01 | 0.00665 | 0.000 | -5.83 |
| 35-39 | 0.00005 | 0.000 | -0.04 | 0.00626 | 0.000 | -5.49 |
| 40-44 | 0.00004 | 0.000 | -0.04 | 0.00674 | 0.000 | -5.91 |
| 45-49 | 0.00045 | 0.000 | -0.40 | 0.00535 | 0.000 | -4.69 |
| **Type of place of residence** | | | **2.47** | | | **8.76** |
| Urban | | Reference | | | Reference | |
| Rural | -0.00282 | 0.000 | 2.47 | -0.00999 | 0.047 | 8.76 |
| **Highest educational level** | | | **-1.05** | | | **9.61** |
| No education | | Reference | | | Reference | |
| Primary | -0.00004 | 0.092 | 0.04 | -0.00098 | 0.393 | 0.86 |
| Secondary | 0.00064 | 0.000 | -0.56 | -0.00786 | 0.063 | 6.89 |
| Higher | 0.00061 | 0.000 | -0.53 | -0.00212 | 0.055 | 1.86 |
| **Religion** | | | **0.45** | | | **-32.31** |
| Hindu | | Reference | | | Reference | |
| Muslim | 0.00076 | 0.000 | -0.67 | 0.00191 | 0.104 | -1.68 |
| Christian | -0.00170 | 0.000 | 1.49 | 0.02704 | 0.000 | -23.71 |
| Other | 0.00042 | 0.000 | -0.37 | 0.00790 | 0.000 | -6.92 |
| **Ethnicity** | | | **0.61** | | | **-26.09** |
| Caste | | Reference | | | Reference | |
| Tribe | 0.00003 | 0.020 | -0.03 | 0.03003 | 0.000 | -26.33 |
| No caste/ tribe | -0.00102 | 0.005 | 0.89 | -0.00012 | 0.925 | 0.11 |
| Don’t know | 0.00028 | 0.002 | -0.25 | -0.00015 | 0.272 | 0.13 |
| **Wealth index combined** | | | **9.85** | | | **6.56** |
| Poorest | | Reference | | | Reference | |
| Poorer | 0.00081 | 0.000 | -0.71 | -0.00029 | 0.893 | 0.26 |
| Middle | -0.00280 | 0.000 | 2.45 | -0.00344 | 0.037 | 3.01 |
| Richer | -0.00481 | 0.000 | 4.22 | -0.00237 | 0.043 | 2.08 |
| Richest | -0.00444 | 0.000 | 3.89 | -0.00138 | 0.013 | 1.21 |
| **Total no of children born** | | | **-0.03** | | | **-1.92** |
| No child | | Reference | | | Reference | |
| One child | -0.00025 | 0.007 | 0.22 | 0.00124 | 0.501 | -1.09 |
| Two child | -0.00090 | 0.000 | 0.79 | 0.00075 | 0.751 | -0.66 |
| Three child | -0.00004 | 0.004 | 0.04 | 0.00148 | 0.361 | -1.30 |
| Four or more child | 0.00123 | 0.000 | -1.08 | -0.00129 | 0.444 | 1.13 |
| **Currently pregnant** | | | **0.01** | | | **-2.51** |
| No or unsure | | Reference | | | Reference | |
| Yes | -0.00002 | 0.011 | 0.01 | 0.00287 | 0.000 | -2.51 |
| **Current marital status** | | | **0.07** | | | **-1.79** |
| Never in union | Reference | | | Reference | | |
| Married | -0.00028 | 0.004 | 0.25 | 0.00197 | 0.788 | -1.72 |
| Widowed/Divorced/Separated | 0.00020 | 0.000 | -0.18 | 0.00008 | 0.908 | -0.07 |
| **Frequency takes milk or curd** | | | **0.37** | | | **-8.37** |
| Never | | Reference | | | Reference | |
| Daily | 0.00009 | 0.024 | -0.08 | 0.00400 | 0.038 | -3.50 |
| Weekly | -0.00062 | 0.007 | 0.55 | 0.00532 | 0.030 | -4.66 |
| Occasionally | 0.00011 | 0.177 | -0.10 | 0.00024 | 0.931 | -0.21 |
| **Frequency eats pulses/beans** | | | **3.43** | | | **7.28** |
| Never | | Reference | | | Reference | |
| Daily | -0.00093 | 0.354 | 0.82 | -0.00037 | 0.970 | 0.33 |
| Weekly | -0.00097 | 0.019 | 0.85 | -0.00374 | 0.723 | 3.28 |
| Occasionally | -0.00200 | 0.000 | 1.76 | -0.00418 | 0.357 | 3.67 |
| **Frequency eats vegetables** | | | **2.53** | | | **69.75** |
| Never | | Reference | | | Reference | |
| Daily | -0.00612 | 0.048 | 5.36 | -0.03659 | 0.138 | 32.08 |
| Weekly | 0.00244 | 0.199 | -2.14 | -0.03292 | 0.032 | 28.86 |
| Occasionally | 0.00079 | 0.514 | -0.69 | -0.01004 | 0.020 | 8.81 |
| **Frequency eats fruits** | | | **-0.2** | | | **-0.42** |
| Never | | Reference | | | Reference | |
| Daily | -0.00000 | 0.866 | 0.00 | 0.00124 | 0.493 | -1.09 |
| Weekly | 0.00076 | 0.288 | -0.67 | 0.00025 | 0.977 | -0.22 |
| Occasionally | -0.00053 | 0.390 | 0.47 | -0.00101 | 0.915 | 0.89 |

| Variables | Difference due to characteristics(E) | | | Difference due to coefficient(C) | | |
|---|---|---|---|---|---|---|
| | Coefficient | P-value | Percent | Coefficient | P-value | Percent |
| **Frequency eats eggs** | | | **0.27** | | | **-2.54** |
| Never | | **Reference** | | | **Reference** | |
| Daily | -0.00009 | 0.487 | 0.08 | 0.00010 | 0.930 | -0.09 |
| Weekly | 0.00027 | 0.535 | -0.23 | -0.00323 | 0.721 | 2.84 |
| Occasionally | -0.00048 | 0.305 | 0.42 | 0.00603 | 0.294 | -5.29 |
| **Frequency eats fish** | | | **1.03** | | | **34.94** |
| Never | | **Reference** | | | **Reference** | |
| Daily | 0.00025 | 0.088 | -0.22 | -0.00460 | 0.010 | 4.03 |
| Weekly | -0.00023 | 0.642 | 0.20 | -0.02418 | 0.014 | 21.20 |
| Occasionally | -0.00120 | 0.032 | 1.05 | -0.01107 | 0.094 | 9.71 |
| **Frequency eats chicken/meat** | | | **-0.36** | | | **-20.07** |
| Never | | **Reference** | | | **Reference** | |
| Daily | 0.00012 | 0.032 | -0.11 | 0.00084 | 0.285 | -0.74 |
| Weekly | 0.00032 | 0.622 | -0.28 | 0.01565 | 0.090 | -13.72 |
| Occasionally | -0.00004 | 0.954 | 0.03 | 0.00639 | 0.359 | -5.61 |
| **Frequency eats fried food** | | | **0.14** | | | **-4.55** |
| Never | | **Reference** | | | **Reference** | |
| Daily | 0.00008 | 0.751 | -0.07 | -0.00694 | 0.125 | 6.09 |
| Weekly | -0.00021 | 0.477 | 0.18 | 0.00633 | 0.194 | -5.55 |
| Occasionally | -0.00003 | 0.338 | 0.03 | 0.00581 | 0.191 | -5.09 |
| **Frequency eats aerated drinks** | | | **-0.23** | | | **-3.25** |
| Never | | **Reference** | | | **Reference** | |
| Daily | -0.00015 | 0.252 | 0.13 | 0.00113 | 0.076 | -0.99 |
| Weekly | 0.00057 | 0.006 | -0.50 | 0.00005 | 0.970 | -0.05 |
| Occasionally | -0.00016 | 0.002 | 0.14 | 0.00252 | 0.484 | -2.21 |
| TOTAL | | | **18.91** | | | **81.09** |

These reflect a growing proportion of women in categories more vulnerable to anemia. In contrast, education (−1.05%), age (−0.46%) and total children born per woman (−0.03%) contributed negatively, indicating a modest protective effect.

Dietary composition also played a notable role. An increase in women consuming pulses/beans (+3.43%) emerged as the most influential dietary factor linked to higher anemia prevalence, followed by vegetables (+2.53%) and milk/curd (+0.37%). Interestingly, aerated drink consumption (−0.23%) showed a slight negative impact overall. These findings suggest that while dietary diversity has improved, the nutritional quality and bioavailability of consumed foods remain critical in effectively addressing anemia.

**Analysis of Differences Due to Coefficients:** After adjusting for compositional factors, 81.09% of the change in anemia prevalence was due to differences in the effects of characteristics, underscoring how shifts in the influence of demographic, socioeconomic, and dietary factors contributed more than changes in their distribution. Among the positive contributors, place of residence (+8.76%) and wealth index (+6.56%) were significant, suggesting a higher anemia risk among certain sociodemographic groups. In contrast, religion (−32.31%), ethnicity (−26.09%), pregnancy status (−2.51%), and age group distribution (−32.13%) helped reduce anemia prevalence.

Dietary behaviors showed complex impacts. Interestingly, vegetable consumption had the highest positive influence (+69.75%), followed by fish consumption (+34.94%). Conversely, increased milk/curd intake (−8.37%) contributed to a reduction in anemia. These findings highlight the need not just to promote dietary diversity, but to ensure that women are consuming foods that genuinely support better iron absorption and improve overall nutritional outcomes.

## Discussion

This study found a significant rise in anemia prevalence among women of reproductive age in Northeast India, from 38.7% in NFHS-4 to 50.1% in NFHS-5, marking an 11.4% increase. The rise is largely attributed to behavioral factors (81.09%), indicating that changes in existing characteristics, rather than population structure alone, contributed most to the worsening anemia trend.

Among the differences attributed to coefficients (effect of characteristics), anemia prevalence was found to be higher in rural areas. This aligns with previous studies suggesting that women living in rural regions often face greater economic challenges, limited access to healthcare, and inadequate nutritional intake all of which contribute to higher anemia levels.[28,30] Surprisingly, this study found that higher wealth levels are linked to greater anemia prevalence. This may be attributed to lifestyle and dietary shifts among wealthier women, including a move away from traditional iron-rich diets toward processed or convenience foods, reduced physical activity, higher stress levels, and increased reliance on supplements over balanced nutrition all of which can contribute to nutritional deficiencies despite greater awareness.[38] However, previous studies have also found that women in the lowest wealth quintiles are typically at higher risk of anemia due to poor dietary diversity, inadequate nutrition, and limited access to healthcare services.[23,28,29] Even religion demonstrated a significant influence on anemia trends, largely due to the substantial decrease observed among Christian women. In Northeast India, where anemia prevalence among women remains high, research has shown that Christian women experience comparatively lower rates, possibly due to better health-seeking behavior, greater dietary diversity, and improved access to healthcare services.[19] However, ethnicity showed a strong negative impact on anemia prevalence, with tribal women experiencing a decline, possibly due to improved nutritional awareness, better access to healthcare, and traditional iron-rich diets.[24] Nevertheless, anemia remains a serious issue in many tribal communities. Studies from Odisha reported high anemia rates among Koya and Matia women, linked to early marriage and high parity.[27] Similarly, in Manipur, Kuki and Paite women showed significantly high anemia prevalence. These findings highlight persistent disparities, suggesting that while some progress has been made, anemia continues to pose a critical health challenge in tribal populations across India.[39] Furthermore, non-pregnant women are often more anemic than pregnant women due to inadequate dietary intake, iron deficiency, and factors such as age, low socioeconomic status, limited education, and cultural practices. This contrasts with research from Northeast India, where pregnant women experience more severe anemia than non-pregnant women.[33] However, other studies have shown that non-pregnant women under 25 are significantly affected.[28] Pregnant women often benefit from antenatal care and iron supplementation, leading to lower anemia rates compared to their non-pregnant counterparts.[40]

Among demographic factors, a decline in the proportion of women across different age groups was associated with a notable reduction in anemia prevalence. Older women tend to have lower anemia rates due to more stable dietary habits, better health awareness, and reduced menstruation-related iron loss. In contrast, younger women, particularly those aged 20–24, show higher anemia prevalence. Studies indicate that anemia decreases with age, with women aged 31–60 exhibiting lower rates than those aged 16–30. This trend reflects better diets, increased health awareness, and decreased iron loss, aligning with patterns observed among women in India.[41,42]

Dietary habits emerged as a key behavioural factor influencing anemia outcomes. Weekly or occasional consumption of vegetables can lead to higher anemia rates due to insufficient intake of essential nutrients like iron, folate, and vitamin C, which are vital for red blood cell production and iron absorption. Irregular consumption of leafy greens, rich in non-heme iron, may not meet daily nutritional needs, especially for women with menstrual blood loss or poor diets, increasing the risk of iron deficiency anemia.[43] Studies also suggest that vegetarian diets may elevate the risk of iron deficiency anemia due to the lower bioavailability of non-heme iron from plant sources. Research indicates that vegetarians often have lower hemoglobin levels compared to non-vegetarians, contributing to higher anemia rates. In India, dietary practices, particularly vegetarianism, affect non-heme iron absorption despite ongoing government interventions.[19,34,36] A similar trend was observed in women's fish consumption patterns, with daily fish consumers having lower anemia rates compared to weekly consumers, despite both groups showing increased anemia prevalence. This is noteworthy, as heme iron in fish is more readily absorbed than non-heme iron from plant sources, helping to reduce anemia. Lower anemia rates among daily fish consumers may result from better iron absorption and improved hemoglobin levels, while weekly consumption may not provide enough iron, especially in iron-deficient populations. Studies highlight the importance of daily fish intake for improving iron status and meeting iron requirements.[35,44] Additionally, daily or weekly consumption of milk and curd can help lower anemia rates due to their rich content of calcium, protein, and vitamin D, essential for overall nutrition and iron metabolism. Dairy products enhance iron absorption and help meet dietary reference intakes for crucial vitamins and minerals, reducing deficiencies linked to anemia. Increased dairy intake is also associated with a lower risk of chronic diseases, indirectly supporting better nutritional status and reducing anemia prevalence. Regular dairy consumption contributes to improved overall health and nutrient balance.[37]

## Conclusion

This study highlights a significant increase in anemia prevalence among women of reproductive age in Northeast India, reflecting an 11.4% overall rise. The primary factor contributing to this increase appears to be behavioural, accounting for 81.09% of the change, indicating that shifts in behavioural characteristics played a more substantial role than changes in population structure. Anemia prevalence was notably higher among women residing in rural areas, those from higher wealth quintiles, non-pregnant women, and individuals with irregular vegetable consumption. These findings highlight the importance of focusing on socio-economic factors, dietary habits, and healthcare access to tackle anemia, particularly in rural areas and among non-pregnant women. Addressing these issues can help reduce anemia rates and improve overall health outcomes in these vulnerable groups.

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