Anaemia Prevalence and Socio-demographic Factors Among Women of Reproductive Age (WRA): A Geospatial Analysis of Empowered Action Groups (EAG) States in India

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Research Article

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**Additional Declarations:**
The author declares that there is no conflict of interest.

Tables 1-3 are available in the supplementary files section.
Abstract:
Anaemia remains a major nutritional-related health concern for women under reproductive age (WRA), in the developing nations like India as well the Indian EAG states. According to NFHS round-5, EAG states constitute 57% of WRA having any form of anaemia, which is higher than the many other states of India, also other developed and developing nations. This study aimed to assess the frequency of anaemia among the WRA in India's eight EAG states. Also, attempt to analyse the causes that are associated with anaemia by the women’s background characteristics with spatial correlation with its co variates across 291 districts of the EAG states. One of the most current Demographic and Health Survey's (DHS) cross-sectional data, NFHS-5th (2019-20) round taken, which is conducted by the IIPS, under the administration of MoFHW, India. This study only included 315069 women under reproductive age (WRA). The variables related to anaemia among women's (WRA) background socio-demographic characteristics were assessed using bivariate statistics and multinominal logistic regression analysis, in order to comprehend spatial correlation between women with their determinant factors. Among the EAG states, the overall prevalence of anaemia was 57%, varying from 42.6% in Uttarakhand to 65.3% in Jharkhand. Multiple logistic regression analyses reveal that the chances of anaemia are remarkably more prevalent in younger women (15-19 years of age), also the women living in rural areas, no educated and primary level educated women, women belonging to the middle to poorest wealth quintile, women no longer living together, women of the Christian religion, women who are not exposed to reading newspapers, underweight BMI women, and scheduled tribe women. Mostly the prevalence is observed in the North-eastern and southeastern states of Bihar, Jharkhand, Odisha, Chhattisgarh, some parts of Madhya Pradesh, Uttar Pradesh, and Rajasthan, which is shown by the hotspot map. According to the findings of this study, numerous factors like family, socioeconomic, educational, awareness, and individual characteristics such as caste and domicile all lead to a high risk of anaemia. The WRA suffers from anaemia as a result of their socioeconomic background and awareness, which leads to a lack of nourishment, and they seek nutrient deficiencies. To overcome this anaemia, multiple discipline policies and initiatives need to take targeting women's wellness and nutritional status, by increasing women's education and socioeconomic status.

Keywords:
Anaemia status, Women under reproductive age, EAG states, Geospatial analysis, Socio-demographic status.

Abbreviations:
Empowered actions groups (EAG), International Institute for Population Sciences (IIPS), Ministry of Health and Family Welfare (MoFHW), and Women Under Reproductive Age (WRA).
Introduction:

Anaemia is a prominent problem in India, with moreover half of women of reproductive age (15-49 years) suffering from it (Global Nutrition Report, 2022). In accordance with the National Family Health Survey 5 (NFHS-5), anaemic women in 15-49 years of age comprised 57.2% of non-pregnant women, 52.2% of pregnant women, and 57.0% of all women aged 15-49 years in India (NFHS-5, 2021). This Anaemia occurs when the amount of red blood cells or the haemoglobin concentrations in them are below the normal levels. Haemoglobin is essential for carrying oxygen, and when there are inadequate red blood cells or haemoglobin, the blood's capacity to supply oxygen to the body's tissues is decreased. And it tends to have various symptoms including weariness, tiredness, vertigo, and breathing difficulties in the anaemic person. The optimum haemoglobin amount required to satisfy physiological requirements differs according to age, gender, location, health behaviours, and reproductive status of a woman. Nutrition deficiencies, especially iron deficiency, occurs due to lower amount of folic, vitamin B12 and A, all of which are significant matters; and infections ailments like malaria, tuberculosis, HIV, and intestinal parasites comprise the most common causes of anaemia (World Health Organization. (n.d.). Anaemia). One of the research studies looked at the frequency and causes of anaemia in women. It was also projected that rural women would have a higher intensity of anaemia than urban women, especially in groups with lower incomes, and that women with a lower body mass index (BMI; 18.5kg) were expected to be at higher risk than healthy or overweight women (Bentley, M. E., & Griffiths, P. L., 2003). Anaemia can pose a serious concern for pregnant women, who are acutely vulnerable, they may tend to the increased risk of both maternal and their infant’s mortality. The global burden of anaemia stays high, especially in lower-income states where such a substantial number of women of reproductive age are presumed to be anaemic. Anaemia caused by iron deficiency is also linked to impaired physical and cognitive growth in their children, as well as decreased productivity among women (World Health Organization. (n.d.). Anaemia). It moreover means that women experiencing a heavy workload without much leisure time are much more likely to be iron deficient. In terms of dietary consumption, women's intake of fruits, vitamin C, and dal is low, which might be one of the expected reasons for anaemia in women (Unisa, S., et. al., 2010). The prevalence and circulation of anaemia in a population are determined by a complicated complex interaction of ideological, environmental, sociocultural, and physiological, which results in global anaemia disparities that represent clear differences respectively developed and developing nations and discrepancy attention to the predictors of iron deficiency anaemia (Balarajan, Y. et. al., 2011). The study (Chellan, R., & Paul, L., 2010) addressed anaemia, one of the destructive cycles for women in India because as girls gets marriage and join motherhood with poor iron status at a quite early age, mostly anaemia was prevalent among them from adolescence into adulthood, that eventually causes maternal comorbidities and low-birth-weight baby. The present research examines the spatial prevalence and consequences of anaemia among reproductive-age women across India’s EAG states. As a result, the government as well as other stakeholders could be able to create evidence-based women's health issues such as anaemia and evaluate the adoption of programs and policies that attempt to make positive contributions for women in order to minimise the predominance of anaemia.
Objectives:

1. To show a spatial analysis on anaemia status of reproductive-age women (15-49 years) in the Empowered Action Groups states of India.

2. To identify the socio-demographic determining factors that lead to anaemia in women of reproductive age.

Study Area:

Based on the 2011 census, the country India comprises eight EAG states (Fig. 1) (Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, and Uttarakhand), and these states contain 277 districts, which increased to 291 (NFHS-5, 2019-20)\(^1\). The Empowered Action Group (EAG) states account for 45.9% of India's overall population, with Uttar Pradesh having the largest population and Uttarakhand having the lowest (Sarkar, R., 2018)\(^14\). In terms of literacy rate, Rajasthan has the lowest female literacy rate (52.66%) in the country. Whereas, Jharkhand and Chhattisgarh are the states which have a higher proportion of the tribal population, where women's education and health condition are lower than in other Indian states. And it varies, between the EAG states' literacy rates, which range from 62.34 percentage in Rajasthan to 77.11 percentage in Uttarakhand (Som, K. S., & Mishra, R. P., 2016)\(^17\).

Methodology:

Data sets: This study was performed utilisation nationwide, comprehensive, cross-sectional survey information collected through the National Survey Health Survey, round 5 (NFHS-5) performed in 2019-20 underneath the administration of the Government of India's Ministry of Health and Family Welfare. Overall anaemia status of women under reproductive years (15-49 years) was assessed with the NFHS women datasets file for the 8 EAG states of India, which included a sample of 3,15,069 women spread over 291 districts. All the datasets were analysed by applying appropriate sampling weights as per DHS guidelines to adjust the probability differences and the sample representativeness.

Anaemia status: The health investigators obtained blood samples for anaemia diagnosis in the NFHS-5 survey with the participants' agreement. Where the samples were collected in a microcuvette from a blood sample that was collected from a finger prick. This anaemia status differs among Women of reproductive age who were classified as pregnant or non-pregnant, based on DHS standards\(^7\). As this anaemia status among pregnant women is seen If the hemoglobin concentration becomes less than 11.0 g/dL, they were classified as mildly anaemic (10.0-10.9 g/dL), moderately anaemic (7.0-9.9 g/dL), and severely anaemic (below 7.0 g/dL) and for non-pregnant women anaemic considers if their haemoglobin level was lower than 12.0g/dL, mildly anaemic 11.0–11.9 g/dL, moderately anaemic 8.0–10.9 g/dL, and severely anaemic lower than 8.0 g/dL.
Variables:

In this study, the predictor variables were women’s age group, place of residence, woman’s educational level, household wealth status, woman’s marital status, religion, media exposure (frequency of reading newspapers), woman’s body mass index (BMI) status considered as independent variables.

Statistical and Geospatial Analysis: The statistical analysis was done by using STATA and MS Excel applications to analyze the raw data of the anaemia status of women under reproductive age among the 8 EAG States (with districts) of India. Bivariate analysis was done among the selected socio-demographic variables with the anaemia status as the dependent variable. Whereas the Multinominal logistic regression was used to assess the correlation between the prevalence of anaemia at various levels with socio-demographic factors. Relative Risk Ratio (RRR) with 95% confidence intervals (CIs) has been utilized to illustrate the findings of the Multinominal logistic regression study. Also, the Geospatial analysis was used to show the spatial distribution, prevalence rate, hotspots, and determinants significance at the different levels (mild, moderate, severe and any anaemia) of anaemia, for this GeoDA and ArcGIS were used.

Results & Discussion:

Figure 1, depicts the occurrences of anaemia status of women under reproductive age in the EAG states in India. In India, 57% of women (aged 15-49 years) suffer from anaemia, which is equal to the EAG states woman’s average anaemia status (57%). In contrast, Bihar, Chhattisgarh, Jharkhand, and Odisha have a higher proportion of anaemia than that of the average at national level (57%). Moderate anaemia had been the most prominent amongst EAG states (Table-1) and it was preceded by moderate and severe anaemia. Chhattisgarh has the highest percentage of severe anaemia (2.6%), then by Odisha (2.5%), Madhya Pradesh (2.3%), Rajasthan (2.3%), Uttarakhand (2.3%), Bihar (2.1%), Uttar Pradesh (2.1%), and Jharkhand (1.9%). Jharkhand seemed to have the highest rates of moderate and mild anaemia (34% and 29.4%, correspondingly), followed by Odisha (32.8% and 29%), Bihar (31.7% and 29.7%), Chhattisgarh (3.2% and 27.1%), Madhya Pradesh (26.6% and 25.7%), Rajasthan (27.9 and 24.1), Uttar Pradesh (24% and 24.3%), and Uttarakhand (19.1 and 21.2%) (Fig. 3).

In ArcGIS, the Getis-Ord Gi* statistics (Standardize Z score) are demonstrated utilizing the polygonal contiguity, where the Inverse distance weighting (IDW) used for Interpolation of the respected district-wise anaemia prevalence among WRA. The figure (Fig. 4) depicts statistical significance hot and cold spots (clustering of high values) (clustering of low values) (Geoda. Documentation). It is apparent through assessing selected techniques and weights that there's evidence of statistical significance concentrations of anaemia status among women under reproductive age within the region.

This hot spots analysis (Fig. 4), depicts the geographical pattern of anaemia in reproductive-aged women from India's EAG states. It shows a clear geographical pattern that is, very high
anaemia prevalence in the southeastern parts of the EAG states of India. It also depicts some of the EAG states in the northeast with a significant incidence of anaemia among women. While in some of the northern, southern, middle, and western parts are only in the middle range of anaemia status which consists of the states of Uttar Pradesh, Madhya Pradesh, Bihar and Rajasthan and the rest of all have a low level of anaemia (especially the Uttarakhand state).

The Moran’s I scatter plot of anaemia level shows a significantly higher Moran’s I value that represents a considerable concentration of anaemia within the districts. The LISA cluster maps are used to show the hot and cold spots with LISA significant map. The hot spot (high-high) is highlighted in red, indicating a high level of iron deficiency in the neighbour district and the cold spot (low-low) is given in blue colour with a low level of anaemia. This map helps to identify the clustering among the neighbour district.

The spatially connection that exists in between dependent and independent variables is shown by bivariate (Bi) LISA (Local Indicators of Spatial Association) maps in Figure-5. Following Bivariate LISA Map A, 14 of 291 districts (approximately 4.8%) had a higher prevalence of anaemic women of reproductive age and a higher proportion of younger women (15-19 years of age) with a Moran’s I value of 0.078 (significant) and the districts were identified to the states of Chhattisgarh, Odisha, some parts of Rajasthan and Uttar Pradesh. Bi. LISA Map B, which demonstrates that 17 of 291 districts (about 7%) had a larger proportion of anaemic women under reproductive age with a higher proportion of rural women residents, with a Moran’s I, value of 0.091 (significant), and the districts consisted primarily of Bihar, Odisha, a few other parts of Uttar Pradesh, and Chhattisgarh. Similarly, the Bivariate LISA map (Map C) revealed that 40 of 291 districts (about 22%) had a significant prevalence of anaemic women under reproductive age and a larger portion of illiteracy among women, with a Moran’s I, value of 0.302 (significant), and the districts constituted primarily Bihar, Odisha, several parts of Uttar Pradesh, and Chhattisgarh. In Map D, total number of 88 districts been classified as high anaemia hotspots. poor wealth status of the household (about 16% of the total districts) with a Moran’s I value of 0.368 (significant) and the districts were identified and the belongs mainly to the states of Jharkhand, Bihar, Odisha, Chhattisgarh, some parts Uttar Pradesh, and Madhya Pradesh while 44 districts were identified as cold spots. Bivariate LISA MAP E shows that 8 of 291 districts (about 2.75%) higher proportion of anaemic women under reproductive age and a higher proportion of married women with a Moran’s I value of 0.030 (significant) and the districts were from the states of Bihar, Jharkhand, and Chhattisgarh. Whereas in MAP F, with a Moran's I value of 0.140, substantial clusters of high anaemia and women who are not reading a newspaper (unexposed to the mainstream media) were detected in 17 of 291 districts mostly in the states of Orissa, Chhattisgarh, Bihar, and certain parts of Uttar Pradesh (significance). As per Map G, around 36 districts constitute hotspots (high anaemia and underweight body mass index women), while 34 districts are cold spots areas (low proportion of anaemic women and low prevalence of Women with underweight BMI status). The districts recognized were mostly from Bihar, Odisha, and Chhattisgarh, as well as a portion of Madhya Pradesh. About 5 districts from Rajasthan, Chhattisgarh found high prevalence with scheduled tribe women and women anaemia with a Moran’s I value of 0.053 as depicted in Map H.
Based on their sociodemographic characteristics, the frequency and related determinants of anaemia condition for women of reproductive age (15-49 years old) discussed (Table 2). Table 2 shows that the frequency of anaemia is higher among women aged 15 to 19, whereas severe anaemia is prevalent among women aged 40 to 44. In terms of place of residence, it's found that rural women are more prone to anaemia (56.9%) as compared to those women who lived in urban areas (53.9%). Interestingly, it is found that women’s educational level has a significant impact on their anaemia status as the results show nearly half of the higher educated women (51%) have anaemia and of more than half of the women who are less educated are more prone to anaemia. Household wealth status has played an important role, and from the results, also clear that the women who belong to more wealth status are a lesser prevalence of anaemia. In the case of social marital practices among women, it’s found that severe anaemia is much high among women who no longer lived together (3.41%) and widowed (3.24%). When it comes to religions, it’s found that Severe anaemia is high among the other minor religions (2.43%) followed by Hindu (2.25), Christian (1.88%), and Muslim (1.85%). But in the case of overall anaemia status, Christian religious women were found to be higher anaemic as compared to others religions. Reading newspaper also plays a significant role in terms of mass media exposure through food intake, health care awareness and others, in this study, it’s found that more anemic women (56.9%) are not exposed to reading the newspaper as a part of mass media followed by less than once a week (55.2%) and at least once a week (52.9%). Women’s nutritional status as by their body mass index it’s found that the women who are underweight category are high prevalence of anaemia (61.5%), and also more prone in terms of severe anaemia (3.11%) as compared to normal, overweight, obesity categories BMI status indexed women. When anaemia status inspects over the different caste categories of women, it is found that about 66.57% of scheduled tribe women are anaemic, followed by scheduled caste (56.47%), other backward castes (54.61%) and general caste (54.25%) categories women.

Table-3 illustrates the results of the multinomial logistic regression analysis performed to determine the possible causes of anaemia, particularly of the reproductive-aged women (15-49 years of age) across India’s EAG states. It shows that 40-44 years aged women who have severe anaemia was 1.2 times (RR= 1.19, P <001) more likely to be severely anaemic as compared to the 15-19 years women. Women whose place of residence is rural 0.9 times (RR=0.91, P<0.05) to be severe, 0.9 times (RR=0.94, P<0.001) to be moderate, 1.0 times (RR=0.95, P<0.001) more likely to be anemia as compared to the women living in the urban areas. Women who are secondary or higher secondary educated are less likely to be anaemia as compared to the women who are primary and not educated in the severe, moderate and mild levels of anaemia, which indicates that lower education or no education has a significant association with women’s anaemia status. Women who belong to the richest households are less likely to be anaemia (severe, moderate, and mild) than women who belong to the middle or poorest wealth quintile. When it comes to the current marital status of women, widowed, and no longer living together women are more likely to be anaemia, followed by married and other women. Muslim religious women are 0.81 times (RR=0.81, P<0.001), to be severe, 0.9 times (RR=0.89, P<0.001) to be moderate, 0.93 times (RR=0.93, P<0.001) to be mild are more likely to be anaemic as compare to other religious women. Reading newspapers as of media exposure among women who reads at least once a week are less likely to be anaemic, as compared to
women who read newspapers less than once a week and women not reading the newspaper or unexposed to the mass media. The underweight body mass indexed women are 3.04 times (RR=3.04, P<0.001), to be severe, 1.44 times (RR=1.44, P<0.001) to be moderate, 1.15 times (RR=1.15, P<0.001) to be mild are more likely to be anaemic as of normal, overweight and obesity body mass indexed women. In respective of the caste category, it found that scheduled caste, scheduled tribe women are more likely to be anaemic compared to the OBC and general castes women. Among the EAG states it is found that women from Uttarakhand are less likely to be anaemia as compared to the other 7 EAG states of India.

Discussion:

Iron deficiency or anaemia is still a serious women’s health issue in South and Southeast Asian nations, with a high frequency among women under reproductive age (Sunuwar, D. R., et al., 2020)\textsuperscript{17}. As reported by the World Health Organization (WHO), in 2019 53% of women under reproductive age (WRA) found the prevalence of anaemia in India (severe 2.4%, moderate 25.4%, mild 25.2%), which is much higher than the global and anaemia status of WRA, 29.9% (World Health Organization., n.d.)\textsuperscript{20}. This Anaemia is a prominent cause of illness and death among reproductive-age women (Sarkar, K. et al., 2016)\textsuperscript{12}. The current research has reaffirmed and expanded on prior results that anaemia among women of reproductive age is a significant public health issue in India. The findings revealed that anaemia is significantly prevalent among women of reproductive age, notably in the EAG states of India. The occurrence of anaemia in women of reproductive age is around 57% in the EAG states, which is significantly higher compared to many other countries. Jharkhand has the most incidence of anaemia among women of reproductive age (65.3%), followed by Odisha (64.3%), Bihar (63.5%), Chhattisgarh (60.8%), Madhya Pradesh (54.7%), Rajasthan (54.4%), and Uttar Pradesh (50.4%). On contrary, among the EAG states, Uttarakhand (42.6%) has the lowest occurrence rate (42.6%). Sharma, H. et al., 2018\textsuperscript{14}, demonstrated the factors, state-by-state distribution, and spatial variation of anaemia occurrence among women of reproductive age based on the National Family Health Survey round-4, which validates the current study’s findings. Across all the EAG states severe anaemia was found very high in the states of Chhattisgarh (2.6%) and Odisha (2.5%). This severity of anaemia may be associated with socioeconomic background, a lack of frequent routine check-ups, and a delay in getting medical attention until symptoms become noticeable and interfere with daily living activities (Hamodi, L. E. et al., 2022)\textsuperscript{6}. According to, Singh, R. K., & Patra, S., 2014\textsuperscript{15} the mother's anaemia condition influences on anaemia status of their infants. It has been demonstrated that children born to highly severe anaemia mothers are more significantly iron deficient than children born to non-anaemic mothers. Women’s ages have a significant impact on their anaemia status. The study found that younger women are more prone to moderate or severe anaemia and are more likely to have anaemia than older women, also study discussed that anaemia increases among women due to the bleeding episode during labour, miscarriage, also higher parity, and insufficient gaps during pregnancy (Manikam, N. R., 2021)\textsuperscript{9}. One of the elements that determine surroundings is the region or place of residence, such as residing in locations that may affect the availability of food and other basic utilities. It has been found that education is associated with anaemia, whereas increasing education reduces the incidence of anaemia among women (Sari, J.,
This, women’s education level is very important, and it has resulted in a better knowledge of the need for an iron-rich dietary, proper hygienic practices, and proper sanitation (K, C., & K, S., 2017). Anaemia is also usually related to the socioeconomic position because of a shortage of nutrients and inadequate health care. Furthermore, the study done in a selected tribal community in India found that women with poor socioeconomic levels were much more prone to anaemia (Ismail, I. et al., 2016).

Conclusion:

The study resultants that the overall prevalence of anaemia in EAG states is 57% of women under reproductive age (WRA), where severe is 2.3%, moderate 28.4% and mild anaemia is found to be 26.3%. This percentage positions as a major public health concern of WRA among the EAG states of India. Additionally, the study explored the sociodemographic factors which are associated with anaemia among the WRA. Moran’s I value, which depicts high autocorrelation and neighbouring high prevalence regions of the EAG states. The occurrence of anaemia of WRA in the four EAG states is high, as of the 8 EAG states, Bihar, Jharkhand, Odisha, and Chhattisgarh found to be an overall higher prevalence of anaemia also by different levels of haemoglobin deficiency, whereas some parts of Uttar Pradesh, Madhya Pradesh and Rajasthan found to be medium as compared to the higher prevalence states and the lowest occurrence of anaemia found in Uttarakhand state. The risk or the major determining factors found to be the women’s younger age, their rural residential settings, illiteracy, or lower level of education among them, their poor socio-economic background status in terms of wealth, unexposed to the reading newspaper or unawareness, their underweight body mass index and their traditional beliefs, caste systems are associated with their anaemia status of WRA. Thus, according to the prevalence of higher rate of anaemia among WRA, the EAG states by emphasizing the importance of the prevalence of anaemia in the sub-populations into different levels of anaemia, where the most frequent surveillance should be helpful. The results of this study will help to hypothesise about the potential or the determining socio-demographic risk factors of anaemia among WRA. This provides an understanding of this concern and figures out the risk zones where these problems are highly concentrated.

References:


Figures

Fig. 1: Location map of the study area, EAG States of India

Figure 1

See above image for figure legend.
Fig. 2: Prevalence of anaemia among women (age 15-49 years) in the EAG States of India, NFHS-5

Figure 2

See above image for figure legend.
Fig. 3: Anaemia status by haemoglobin level (a, b & c) among women (age 15-49 years) in the EAG States of India, NFHS-5

Figure 3

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Figure 4

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Figure 5

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