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Socio-economic Inequities and Anemia in Pregnancy in Gajapati District of Odisha: An Empirical Inquest

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Abstract - **Anemia in pregnancy presents a critical public health concern in developing countries, including India, as it is associated with increased risks of maternal complications and adverse fetal outcomes. This study investigates the socio-economic and demographic variables associated with anemia during pregnancy in Gajapati district, Odisha, an aspirational district with a significant tribal population. A cross-sectional survey was carried out at the community level involving 151 pregnant women. Data were collected through semi-structured interviews, and hemoglobin levels were recorded from 'Mother and Child Protection' (MCP) cards issued under the National Health Mission. Statistical analysis using SPSS (v20) included descriptive statistics, bivariate analysis, and binary logistic regression. The results revealed a 37.75% prevalence of anemia, with 12.58% experiencing moderate anemia. Significant associations were found between anemia and educational level ($p = 0.004$), maternal age ($p = 0.001$), and rural residence ($p = 0.007$), while factors such as income and family size showed no significant impact. These findings highlight the importance of focused health education, improved access to antenatal care, and enhanced outreach through SHGs and ASHA workers in tribal and underserved areas. The study contributes to the evidence base for designing context-specific interventions aligned with national nutrition and maternal health strategies.**

Keywords: **Anemia, Pregnant Women, Socio-economic Factors, Hemoglobin, Health**

I. INTRODUCTION

Anemia during pregnancy remains a critical global health issue adversely affecting physical health, cognitive development, and overall productivity, while also reflecting broader socio-economic disparities (Liyew et al., 2021). Although anemia can affect all population groups, pregnant women and young children are particularly vulnerable to this hematological disorder (De Benoist et al., 2008).

Reducing anemia in pregnancy is vital for lowering maternal and infant mortality rates (Shi et al., 2022; Thangaleela & Vijayalakshmi, 1994) and mitigating severe complications (Sharma & Nagar, 2013; Valsamakis et al., 2019; Zhang et al., 2022). It can result in intrauterine growth restriction and inadequate gestational weight gain (Salam et al., 2013; Shekaili et al., 2024), thereby increasing the risks of preterm delivery, low birth weight, infection susceptibility, and both maternal and neonatal mortality (Dande et al., 2024; Kansal et al., 2004; Silva et al., 2024). Moreover, iron deficiency in infants under six months is associated with long-term cognitive and memory impairments (Congdon et al., 2012).

According to World Health Organization, hemoglobin levels below 11 g/dL in pregnant women indicate anemia. (Dorsamy et al., 2020; Cook et al., 1992). Contributing factors include poor dietary intake, frequent pregnancies, and limited access to antenatal and postnatal healthcare services (Maka et al., 2017; Thangaleela & Vijayalakshmi, 1994; Toteja et al., 2007).

Globally, over two billion people suffer from anemia, with iron deficiency anemia (IDA) being the most prevalent form, accounting for nearly 75% of anemia cases in pregnancy. While anemia affects populations worldwide, its burden is disproportionately high in low and middle-income countries. According to the United Nations, more than 50% of pregnant women in economically disadvantaged nations like India are anemic (Mason et al., 2005). The highest prevalence rates are reported in South-East Asia (48.15%), followed by Africa (46.16%) and the Eastern Mediterranean (40.91%) (Agarwal & Rets, 2021).

Anemia is particularly common among pregnant women in eastern India, the poorest households, adolescents, and those

without formal education. Severity is notably higher among tribal women and the uneducated, who are four times more likely to develop severe anemia (Acharya et al., 2021; Kuppusamy et al., 2024). Although several studies have examined general determinants of anemia, limited data are available on pregnant women residing in marginalized regions (Dominic et al., 2023; Katekar & Deshmukh, 2022; Kumar et al., 2020; Prasad et al., 2023; Singh et al., 2021).

Despite the implementation of national nutrition programs and policy reforms such as the Anemia Mukt Bharat campaign and Iron-Folic Acid (IFA) supplementation, the prevalence of anemia remains alarmingly high due to systemic barriers (Bhatia et al., 2018; Natekar et al., 2022; Rai et al., 2018). These barriers include low health literacy, entrenched cultural dietary patterns, early marriage, inadequate antenatal care, and persistent food insecurity (Ghosh et al., 2020).

Notably, National Family Health Survey (NFHS-4 and NFHS-5) reveals a marginal national increase in anemia among women aged 15-49 years, from 61.8% to 62.2%. However, in Odisha, and more critically in Gajapati district, the situation has deteriorated significantly, with anemia prevalence among pregnant women in Gajapati nearly doubled, rising from 38.6% to 77.4% in recent years (Ministry of Health and Family Welfare).

Gajapati district, marked by its predominantly tribal population, underdeveloped healthcare infrastructure, and entrenched socio-economic vulnerabilities (Pattanaik et al., 2025), is one of India's 112 aspirational districts identified under the NITI Aayog's 2018 initiative (Gautam et al., 2023). Although research has addressed broad maternal health indicators across aspirational districts, limited studies have specifically investigated maternal anemia in Gajapati, which represents a particularly vulnerable population segment (Sarkar et al., 2021). The lack of localized data significantly hinders the development of effective, context-sensitive interventions (Pattanaik et al., 2025). This study examines the prevalence of anemia among pregnant women in the tribal-dominated Gajapati district of Odisha. It explores the socio-demographic and economic determinants influencing anemia (Rishi et al., 2022). The key objectives are: (i) to assess the prevalence of anemia among pregnant women in Gajapati district, with a focus on tribal populations, (ii) to examine the association between socio-demographic and economic variables, such as age, education, and rural-urban residence, and anemia risk, and (iii) to generate localized insights for targeted public health and nutrition interventions.

The statistical significance of these variables is analyzed through bivariate and logistic regression methods. Aligned with SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 5 (Gender Equality), and SDG 10 (Reduced Inequalities), the findings aim to inform equitable healthcare strategies and support India's anemia reduction agenda through region-specific planning.

II. Materials And Methods

Study Area

Gajapati district, located in the southern part of Odisha, India (between 19°6'–19°39' N latitude and 83°48'–84°08' E longitude), spans an area of 3,850 sq. km. (Fig 1). As per the 2001 Census, it has a population of 5,77,817, comprising 6.81% SC, 54.29% ST, and 38.92% OBC. Situated in the North Eastern Ghat Agro-Climatic Zone, the district features an undulating terrain and faces frequent droughts, with temperatures ranging from 10°C to 40°C and average annual rainfall of 1403.30 mm. Gajapati includes one subdivision, three tahasils, seven blocks, 129 Gram Panchayats, one Municipality, and one Notified Area Council, covering 1,619 villages. With a sex ratio of 1042 females per 1000 males and a literacy rate of 54.29%, the district has a significant tribal population (47%). The concentration of tribal communities across blocks underscores the critical need for accessible healthcare services

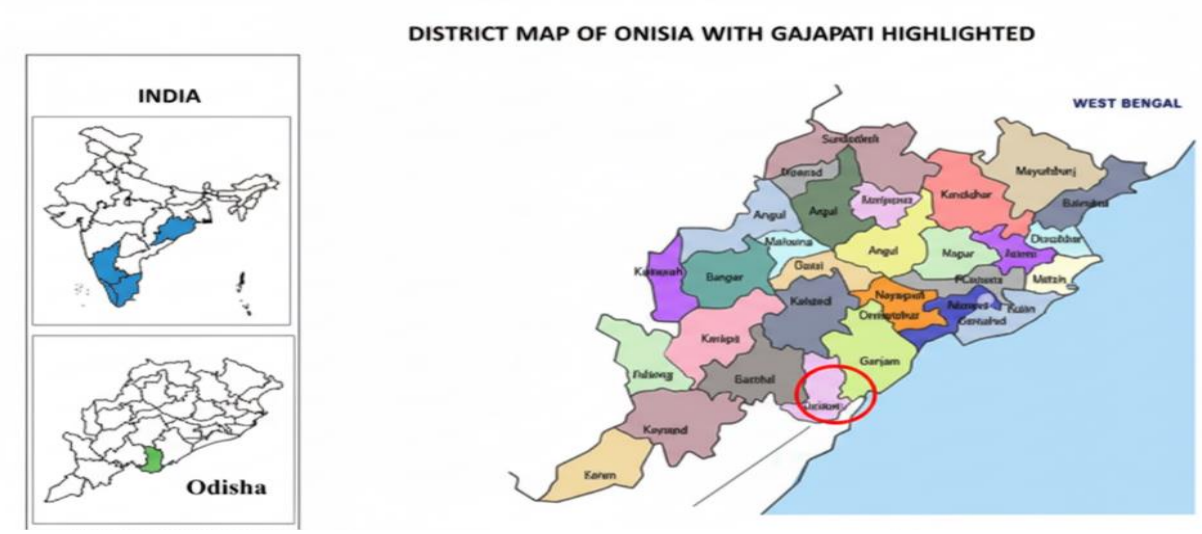

Fig. 1 Location Map of Gajapati District, Odisha

Methodology

This cross-sectional, community-based study was conducted between March and April 2024 in Gajapati district, Odisha, to identify factors associated with anemia among pregnant women from diverse socio-demographic and economic backgrounds. Hemoglobin data were collected from the 'Mother and Child Protection' (MCP) cards issued by the Health Department under the National Health Mission.

A sample of 151 pregnant participants were selected according to the following inclusion parameters: age between 15-49 years, confirmed pregnancy, residence in Gajapati district, informed consent, and absence of chronic conditions such as diabetes or hypertension. Women who did not meet these criteria or were unable to complete the interview were excluded.

The sample size was determined according to standard regression analysis guidelines, requiring at least 5 to 10 times the number of variables studied, making 151 respondents adequate for statistical analysis. Data were collected using a semi-structured, pre-tested questionnaire developed in consultation with maternal health experts. The questionnaire included sections on:

- Socio-demographic characteristics: age, education, income, caste, religion, occupation, residence;
- Reproductive history: age at marriage, number of pregnancies, child spacing;
- Household factors: family size, house ownership, SHG/SGSY membership;
- Health and nutrition: hemoglobin concentration.

To ensure clarity and cultural relevance, the questionnaire was structured in a simple-to-complex sequence using locally understandable language. Trained field investigators explained the study objectives and data collection process before obtaining informed consent Anemia classification followed WHO guidelines (Table I).

TABLE I WHO CLASSIFICATION OF ANEMIA BY HEMOGLOBIN LEVEL IN PREGNANT WOMEN

Hemoglobin level in the blood	**WHO criteria**	
Normal	11 g/dL or higher for children	
Mild	10–10.9 g/dL	<12 g/dL anemic for pregnant women
moderate	7–9.9 g/dL	

Source: NFHS-4, 2015-16, Indian Government, International Institute for Population Sciences

SPSS version 20 was employed for statistical analysis of the data. Data consistency, completeness, homogeneity, and absence of multicollinearity were all verified. To determine the predictors of anemia, binary logistic regression was conducted using anemia status (anemic vs. non-anemic) as the outcome variable. Statistical significance was determined at $p \leq 0.05$, and results were expressed as odds ratios (OR) with 95% confidence intervals (CI) (Fig 2).

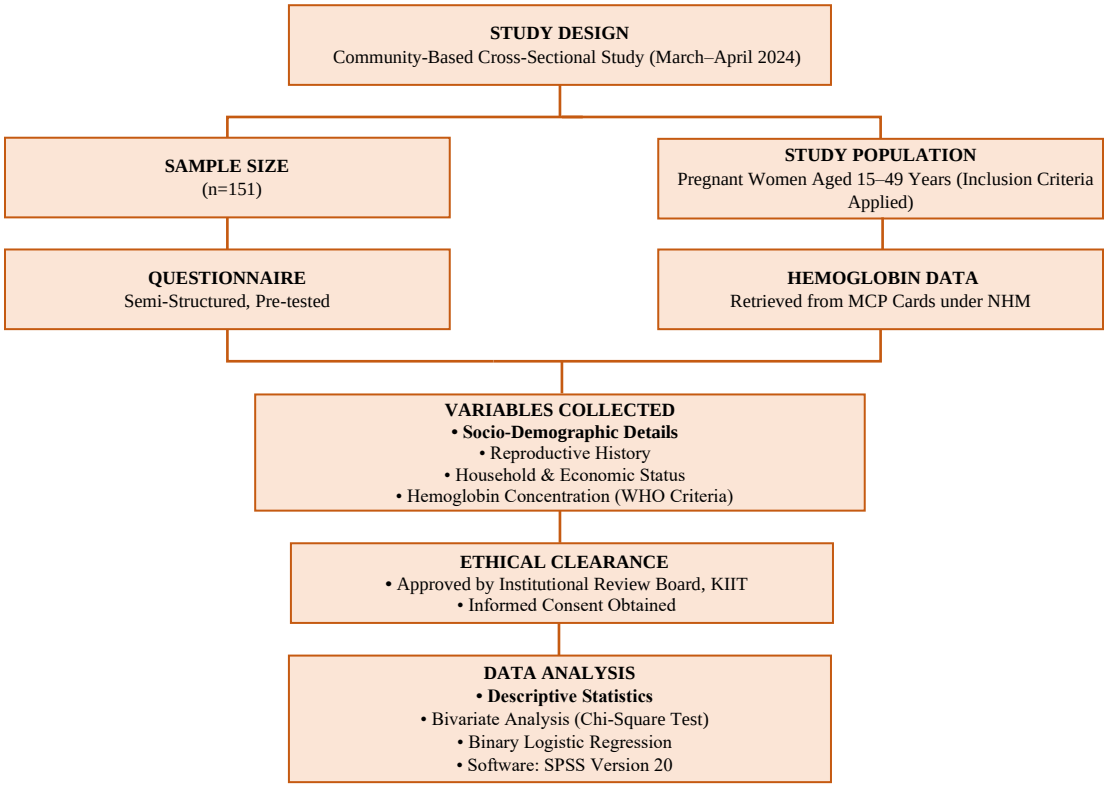

Fig. 2 Study Methodology Flowchart

Ethical Issues & Informed Consent

Ethical approval for the study was obtained from the Institutional Review Board of Kalinga Institute of Industrial Technology (KIIT), Bhubaneswar. All participants provided written informed consent prior to participation. Anonymity and confidentiality were strictly maintained throughout the study.

III. Results

The study found a 37.75% prevalence of anemia among the 151 pregnant women assessed, including 25.17% with mild anemia and 12.58% with moderate anemia. Severe anemia was not detected in any participant (Fig. 3). The remaining 62.5% of the participants exhibited hemoglobin concentrations within the normal range (≥11 g/dL), as shown in Figure 3. Participants' mean age was 28.0 ± 2.91 years, with 79.5% belonging to the 19-29 age group. Most participants had low educational attainment, with 85.4% educated up to primary level. The majority were engaged in agriculture-related occupations (84.8%) and resided in rural areas (70.9%). Over three-fourths had a monthly household income between ₹20,000 and ₹30,000, and nearly 95% had married before the age of 20. Table II presents the full socio-demographic profile.

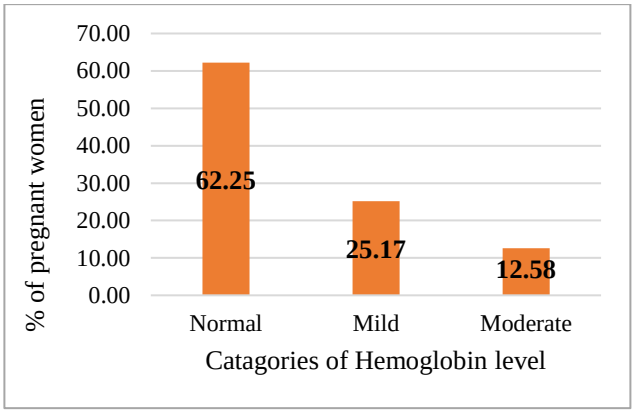

Fig. 3 Distribution of anemia cases by severity among pregnant participants (%)

TABLE II SOCIO-DEMOGRAPHIC ATTRIBUTES OF THE STUDY POPULATION

Variables	Frequences	%
1. Age range (in years)		
a- (15-19)	4	2.6
b- (19-29)	120	79.5
c- (29-39)	24	15.9
d- (39-49)	3	2.0
2. Education level		
a- (Illiterate)	2	1.3
b- (Primary)	129	85.4
c- (Secondary)	14	9.3
d- (Bachelors)	5	3.3
e-(Masters or above)	1	.7
3. Occupation type		
a- (Related to agriculture)	128	84.8
b- (Governmental worker)	12	7.9
c- (Business)	7	4.6
d- Others (*specify*)	4	2.6
4. Family size		
a- (2)	11	7.3
b- (3)	12	7.9
c- (>3)	128	84.8
5. Monthly household income		
a- (<10000)	12	7.9
b- (10000-20000)	9	6.0
c- (20000-30000)	117	77.5
d- (>30000)	13	8.6
6. Age at your marriage (*in years)*		
a- (15-20)	143	94.7
b- (20-25)	6	4.0
c- (25-30)	1	.7
d- (>30)	1	.7
7. Religion (Caste/Tribe)		
a- (Hindu) (Sub Caste)	139	92.1
b- (Muslim)	12	7.9
8. Social group		
a- (SC/ ST)	133	88.1
b- (OBC)	3	2.0

c- (General)	11	7.3
d- Can't say	4	2.6
9. Residence status		
a- (Urban)	44	29.1
b- (Rural)	107	70.9
10. Age of 1st pregnancy		
a- (18-22)	38	25.2
b- (23-27)	108	71.5
c- (27-32)	4	2.6
d- (More than 35)	1	.7
11. Number of pregnancy (including current)		
a- (1)	19	12.6
b- (2)	111	73.5
c- (3)	20	13.2
d-(More than 3)	1	.7
12. Years of last child spacing		
a- (Less than 3)	117	77.5
b- (3-4 years)	13	8.6
c- (No child before)	21	13.9
13. Membership of SHG and/or SGSY		
a- (SHG)	14	9.3
b- (SGSY)	1	.7
c- (Not a member of SHG)	135	89.4
d- Others (*specify*)	1	.7
14. House ownership		
a- (Rented house)	21	13.9
b- (Own house)	125	82.8
c- (House over unauthorized land)	2	1.3
d- Others (*specify*)	3	2.0

Source: Author's analysis

Bivariate analysis was conducted to explore associations between anemia status and key demographic and socioeconomic variables. Significant associations ($p < 0.05$) were found with:

- Age group ($\chi^2 = 4.211$, $p = 0.003$)
- Educational level ($\chi^2 = 5.370$, $p = 0.012$)
- Residence status ($\chi^2 = 6.001$, $p = 0.031$)

This indicated that younger women (aged 15-19 and 29-39 years), those with lower education (primary-educated), and those from rural areas had higher anemia prevalence. Other variables such as occupation, family size, household income, age at marriage, religion, social group, number of pregnancies, and membership in self-help groups did not yield statistically significant results in relation to anemia at the 5% level (Table III).

TABLE III BIVARIATE ANALYSIS OF PERSONAL VARIABLES AND ANEMIA STATUS

Variables	Frequences	Normal (n=94) %	Anaemic (n=57) %	Chi value	P value
1.Age range (in years)				4.211	0.003
a-(15-19)	4	3	1		
b-(19-29)	120	73	47		
c-(29-39)	24	16	8		
d-(39-49)	3	2	1		
2.Education level				5.370	0.012
a-(Illiterate)	2	0	2		
b-(Primary)	129	82	47		
c-(Secondary)	14	9	5		
d-(Bachelors)	5	3	2		
e-(Masters or above)	1	0	1		
3.Occupation type				0.799	0.699
a-(Related to agriculture)	128	80	48		
b-(Governmental worker)	12	8	4		
c-(Business)	7	5	2		
d-Others (*specify*)	4	1	3		
4.Family size				0.004	0.152

a-(2)	11	5	6		
b-(3)	12	9	3		
c-(>3)	128	80	48		
5.Monthly household income				0.613	0.142
a-(<10000)	12	5	7		
b-(10000-20000)	9	5	4		
c-(20000-30000)	117	76	41		
d-(>30000)	13	8	5		
6.Age at your marriage (*in years)*				0.057	0.821
a-(15-20)	143	90	53		
b-(20-25)	6	3	3		
c-(25-30)	1	0	1		
d-(>30)	1	1	0		
7.Religion (Caste/Tribe)				0.441	0.473
a-(Hindu) (Sub Caste)	139	86	53		
b-(Muslim)	12	8	4		
8.Social group				0.351	0.594
a-(SC/ ST)	133	83	50		
b-(OBC)	3	2	1		
c-(General)	11	7	4		
d-Can't say	4	2	2		
9.Residence status				6.001	0.031
a-(Urban)	44	29	15		
b-(Rural)	107	65	42		
10.Age of 1st pregnancy				0.454	0.432
a-(18-22)	38	14	24		
b-(23-27)	108	77	31		
c-(27-32)	4	3	1		
d-(More than 35)	1	0	1		
11.Number of pregnancy (including current)				0.401	0.531
a-(1)	19	12	7		
b-(2)	111	69	42		
c-(3)	20	13	7		
d-(More than 3)	1	0	1		
12.Years of last child spacing				0.499	0.480
a-(Less than 3)	117	73	44		
b-(3-4 years)	13	8	5		
c-(No child before)	21	13	8		
13.Membership of SHG and/or SGSY				0.210	0.271
a-(SHG)	14	9	5		
b-(SGSY)	1	0	1		
c-(Not a member of SHG)	135	85	50		
d-Others (*specify*)	1	0	1		
14.House ownership				0.607	0.612
a-(Rented house)	21	15	6		
b-(Own house)	125	74	51		
c-(House over unauthorised land)	2	2	0		
d-Others (*specify*)	3	3	0		

Source: Author's analysis

To control for confounding factors, a binary logistic regression was applied. Three predictors emerged as statistically significant:

- Maternal age (OR = 0.851, 95% CI: 0.759–0.955, p = 0.001):
- Education level (OR = 0.199, 95% CI: 0.072–0.099, p = 0.004
- Residence status (OR = 0.268, 95% CI: 0.095–0.126, p = 0.007)

These results indicate that younger age, lower educational attainment, and living in rural areas significantly increased

the likelihood of anemia. Other variables, including income, occupation, family size, age at marriage, religion, parity, and SHG membership, did not show significant associations (Table IV).

TABLE IV BINARY LOGISTIC REGRESSION ANALYSIS OF PREDICTORS OF ANEMIA)

Variables	$\boldsymbol{\beta}$ (for standardized regression coefficient)	$\boldsymbol{p\ value}$	Odds ratio (OR)	95 % Confidence Interval (CI) for Exp ($\boldsymbol{\beta}$)	
				Lower	Upper
1.Age range (in years)	-0.232	0.001*	0.851	0.759	0.955
2.Education level	−1.713	0.004*	0.199	0.072	0.099
3.Occupation type	0.514	0.551	0.441	0.473	0.478
4.Family size	0.143	0.233	0.351	0.594	0.599
5.Monthly household income	0.517	0.254	0.334	0.131	0.948
6.Age at your marriage (*in years)*	0.401	0.762	0.454	0.432	0.531
7.Religion (Caste/Tribe)	0.766	0.685	0.401	0.531	0.841
8.Social group	0.355	0.601	0.499	0.480	0.970
9.Residence status	-1.018	0.007*	0.268	0.095	0.126
10.Age of 1st pregnancy	0.640	0.591	0.499	0.480	0.491
11.Number of pregnancy (including current)	0.336	0.784	0.210	0.271	0.377
12.Years of last child spacing	0.382	0.712	0.607	0.612	0.924
13.Membership of SHG and/or SGSY	0.500	0.544	0.799	0.601	0.720
14.House ownership	0.328	0.308	0.017	0.121	0.333
Constant	6.013	0.009	2888.116		

*Significant at p value of <0.05

Source: Author's analysis

IV. Discussion

This study underscores the persistent burden of anemia among pregnant women in Gajapati, Odisha, with over one-third affected, pointing to continued public health vulnerability in this tribal-dominated district. The study identifies maternal age, education level, and rural residence as prominent socio-demographic determinants of anemia, consistent with findings across South Asia and similar underserved regions (Ahmed, 2000; Ahmed et al., 2003; Akhtar, 2016; Gillespie, 1997; Hyder et al., 2004).

Educational attainment emerged as a critical factor, aligning with global evidence that literacy improves awareness, increases antenatal care utilization, and facilitates consistent intake of IFA supplements (Araujo Costa & de Paula Ayres-Silva, 2023; Eweis et al., 2021; Sarker et al., 2021). Education plays a transformative role to empower women to make autonomous and well-informed decisions regarding nutrition and healthcare, thereby strengthening both preventive and curative aspects of maternal care (Ramachandran et al., 2023; Kumar et al., 2022). Younger maternal age was also found to increase anemia vulnerability, primarily due to elevated physiological requirements and socio-economic disadvantages linked to adolescent pregnancies (Rammohan et al., 2024; Valsamakis et al., 2019). Similarly, residing in rural areas continues to influence anemia outcomes due to limited access to diverse diets, essential maternal health services, and education opportunities (Ghosal et al., 2023; Nyarko et al., 2023).

Although national initiatives such as Anemia Mukt Bharat have made important strides, rural and tribal regions still face implementation challenges, especially in terms of IFA supplement distribution and limited outreach through counseling and education.

Interestingly, socio-economic variables such as household income and family size did not show a statistically significant relationship with anemia, suggesting that financial means alone may not be sufficient to ensure maternal nutritional adequacy, especially in contexts where food practices and intra-household hierarchies may marginalize women (Ayub et al., 2009). These findings underscore the importance of incorporating social, cultural, and behavioral perspectives into anemia reduction strategies.

The study reaffirms the value of early iron supplementation and nutrition-focused interventions during pregnancy (Khambalia et al., 2009; Quadrat-E-Elahi et al., 2011; Cuence et al., 2020). It also highlights complex interplay of factors contributing to anemia, not limited to diet, but also by socio-educational status, geographic isolation, and cultural norms (Pradhan et al., 2022). The community-based nature of the sample strengthens external validity and enhances the potential applicability of findings to other similarly structured tribal populations.

These results emphasize the importance of designing region-specific, culturally responsive strategies to address anemia among pregnant women in tribal and rural areas. Interventions should consider not just economic support but also educational and cultural contexts. Strengthening the capacity of frontline workers such as ASHA personnel and self-help groups (SHGs) skill-based training, ensuring uninterrupted IFA supply, and integrating anemia screening into routine antenatal care at sub-centers and PHCs are crucial priorities. Additionally, developing culturally appropriate IEC materials in local dialects and promoting girls' education and delayed marriage can also contribute to

long-term prevention. Future research should consider longitudinal and mixed-methods approaches to examine hemoglobin trends, explore behavioral and cultural barriers to IFA adherence, and assess the effectiveness of digital tools for supplement tracking. Such integrated efforts will contribute meaningfully to the goals of Anemia Mukt Bharat and the National Nutrition Mission through more inclusive and evidence-driven public health actions.

V. Conclusion

This study explored the prevalence and socio-demographic predictors of anemia in women during pregnancy in Gajapati district, Odisha, a primarily tribal region with constrained access to health services and adequate nutrition. Anemia was observed in 37.75% of pregnant women, with elevated risk noted among younger women, those with lower levels of education, and residents of rural areas. These results highlight persistent socio-structural barriers to maternal health and emphasize the need for interventions that are tailored to the capacities and realities of local health systems.

The public health importance of this study lies in its contribution to understanding anemia in marginalized populations beyond clinical settings. By generating community-based evidence, it supports more equitable healthcare planning in tribal areas. The study reinforces the need for localized nutrition education, strengthened antenatal care, and ensuring consistent IFA supplementation through ASHAs and SHGs. Furthermore, it offers insight into tailoring IEC campaigns for low-literacy populations and suggests digital monitoring tools for tracking supplementation compliance.

This research adds to the current knowledge by focusing on a previously under-studied region and identifying primary risk factors for anemia in pregnant women at the community level. Its findings are particularly relevant for policy formulation, improving program implementation, and optimizing resource allocation in India's ongoing efforts to reduce maternal anemia. Longitudinal and mixed-methods research is recommended to further explore behavioral, dietary, and cultural dynamics affecting maternal nutrition. To our knowledge, this is among the few community-based studies conducted in an aspirational tribal district, providing locally relevant evidence to guide policy development and implementation.

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