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ASSESSMENT OF THE RELATIONSHIP BETWEEN SOCIO-DEMOGRAPHIC AND ANTHROPOMETRIC FACTORS AND THE PREVALENCE OF ANAEMIA AMONG TRIBAL ADULT WOMEN IN NANDURBAR DISTRICT, NORTH MAHARASHTRA, INDIA

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Abstract
According to the World Health Organization (WHO), there are two billion people with anaemia in the world and half of the anaemia is due to iron deficiency. The objective of the study was to estimate the prevalence of anaemia by estimating haemoglobin levels in tribal adult women**.** **Methodology:** The current study utilized a cross-sectional design conducted within the community during the month of May 2022.The survey area was restricted to villages of Akkalkuwa tehsil and Akkalkuwa town of Nandurbar district of North Maharashtra only. A house to house survey was conducted in the selected cluster. Keeping in mind the objectivesof the study, structured pretested questionnaire along with a face-to-face interview was conducted to collectthe data under different heads. Anthropometric measurements were taken following standard procedures. The levels of Hb in tribal adult women were estimated using the HemoCue system. **Results:** A total of 120 tribal adult women were studied. The study revealed that 40% adult women were in between the age group of 21–25 years, 85.83% women were married, and 68.33% women were farm laborers. Prevalenceof anaemiaamong adult women was observed 53.33%. Significant associations were found between anaemia and age, BMI, socioeconomic status, and dietary patterns ($p < 0.01$). Underweight women and those from lower socioeconomic classes showed higher anaemia rates, while non-vegetarians are more likely to be non-anaemic. **Conclusion:** High anaemia rates among tribal women in Akkalkuwa, Nandurbar district, Maharashtra, demand targeted interventions: nutrition education, dietary diversification, and better healthcare access to address this issue.

Keywords: Anaemia, Haemoglobin, Iron, North Maharashtra, Tribal Adult Women.

Introduction

The World Health Organization (WHO) reports that over two billion people worldwide suffer from anaemia, with iron deficiency accounting for half of these cases[1]. Since anaemia is a late indicator of iron deficiency, the prevalence of iron deficiency is estimated to be 2.5 times higher than that of anaemia[1,2]. In India, anaemia remains a major public health issue, particularly in rural and tribal areas[3,4]. According to the NFHS-5 (2019-21) survey, 57% of women of reproductive age and 25% of men were anemic, marking an increase from the NFHS-4 findings[5].

Scheduled Tribes, as economically and socially disadvantaged groups, often experience cultural isolation and have unique dietary practices. Geographically, tribal populations face limited access to formal education, inadequate health practices, sociocultural restrictions, poverty, and reliance on traditional agriculture for their livelihoods[6,7].The Census of India 2011 reports that only 14% of the tribal population in rural areas have access to drinking water facilities, while 22.6% of households lack toilet facilities. Maharashtra has the second-largest tribal population in India (approximately 10.5 million) after Madhya Pradesh[8,9]. Numerous studies have been published on various aspects of tribal health, including child nutrition, cultural issues, food patterns, and dietary practices[10,11,12].

Anaemia is a critical public health issue among women across various physiological groups in Maharashtra's rural and tribal regions[13]. Census 2001 data reveals that the Bhils represent the largest tribal community in the state, making up about 21.2% of Maharashtra's scheduled tribe population. Tribal women experience high anaemia rates, and the overall tribal community suffers from inadequate food intake[7,8]. According to the 2011 Census, Nandurbar, a district in Maharashtra in western India, has a significant tribal population, particularly in two of its six talukas, Akkalkuwa and Akrani (Dhadgaon), located in the Satpura Hills. The district has a total population of 16 lakhs, with tribals making up 69% of the population. This high percentage underscores the district's prominence as a tribal-majority region[8].

Poor eating habits significantly contribute to the development of iron deficiency anaemia, a key indicator of poor health status[14]. Additionally, large-scale studies indicate that low socioeconomic status and limited education are primary factors driving anaemia in women[15,16,17]. Women with low education levels often lack awareness of food quality and nutritional content, which, combined with lower socioeconomic conditions, increases their risk of undernutrition and anaemia due to inadequate food intake[18,19,20]. Unhygienic practices and limited access to safe drinking water further hinder the body’s ability to absorb nutrients effectively[21]. Furthermore, high fertility rates, intensive physical labour, parasitic infections, and menstrual issues also play a substantial role in causing anaemia in women[22,23].

This study aimed to assess the relationship between socio-demographic and anthropometric factors and the prevalence of anaemia among tribal adult women in Nandurbar District, North Maharashtra, India. The specific objective was to estimate the prevalence of anaemia by measuring hemoglobin levels in tribal adult women from Akkalkuwa tehsil in Nandurbar District

Material and Methods

Study Setting

This research utilized a community-based cross-sectional design conducted in May 2022. The study was carried out within the community setting to ensure direct and relevant data collection.The survey area was restricted to villages of Akkalkuwa tehsil of Nandurbar district of North Maharashtra only. Samples were collected from Akkalkuwa town and villages under this tehsil.

Sample Size and Sampling Design

Cluster sampling was used for selecting the settings and samples. Total 120 tribal adult women were selected by adopting a cluster samplingtechniquefollowed bysimplerandom sampling procedure.The sample size per cluster was 30 tribal adult women.

Inclusion Criteria and Exclusion Criteria

Tribal adult women from selected households were eligible to participate if they met certain criteria:

they had lived in the study area for at least six months, were present in a selected household during data collection, belonged to a tribe in Akkalkuwa tehsil, Nandurbar District, Maharashtra, and provided consent to participate. The study focused on physically healthy tribal adult women aged 21 to 35 years who were non-pregnant, non-lactating, and available at home during the survey. Tribal adult women were excluded if they were seriously ill, had recently received a blood transfusion, had chronic medical conditions, or were diagnosed with hemoglobinopathies, bleeding disorders, or had experienced antepartum hemorrhage.

Study Tools

The study utilized various tools and techniques to collect anthropometric and health data. Standing height was measured with a portable anthropometer, from the vertex (the highest point of the head) to the floor. Weight was recorded using a digital weighing scale, and Body Mass Index (BMI) was calculated by dividing the weight in kilograms by the square of the height in meters (kg/m^2). Haemoglobin (Hb) levels in tribal adult women were measured with the HemoCue system, a reliable method for determining blood haemoglobin concentrations. These standardized tools and procedures ensured accurate and consistent measurements throughout the study.

Data Collection

A house-to-house survey was conducted in the selected cluster. To meet the study's objectives, data collection involved a structured, pretested questionnaire combined with face-to-face interviews to gather information on personal details (name, age, sex) and socio-economic factors (education, occupation, monthly income) from each participant. Standard procedures were followed for all anthropometric measurements.

Haemoglobin (Hb) levels in tribal adult women were measured using the HemoCue system. This system requires a single drop of blood from a finger prick, drawn into a cuvette and inserted into a portable, battery-operated device, which displays the Hb concentration on a digital screen. Hb estimation was performed on the spot after the interview, using the HemoCue 301, either at the respondent's home or a public health center, ideally outside in daylight. Verbal consent was obtained after participants were given a clear explanation of the study's purpose. The collected data were then entered into computer software and reviewed for consistency and outliers before analysis.

Data Analysis

World Health Organization (WHO, 2011) has defined "anaemia" as "mild, moderate, or severe based on the following cut-off values (g/dl) for haemoglobin level for non-pregnant: Mild=11-11.9, Moderate=8.0-10.9, Severe=<8.0 For population-level analyses, evaluators may use mean haemoglobin level (a continuous variable) instead of the above categories of mild, moderate, or severe anaemia"[(24)].

All data were entered into Microsoft Excel 2016, and quantitative analysis was performed using the Windows-compatible Online SPSS Statistics Base v28.0. Categorical variables were presented as counts (n) and percentages (%), while continuous variables were reported as mean ± standard deviation (SD).Descriptive statistics, including frequency distributions and percentages, were used to summarize the data. Inferential analysis, specifically the Chi-square test, was conducted to examine associations between the study outcomes and explanatory variables, with the significance level set at $P < .01$.

Results

Table 1: Demographic characteristics of study participants *(n=120)*

Variable	**Category**	***(n =120)***	***(%)***
Age (in years)	21 to 25	48	40
	26 to 30	46	38.33
	31 to 35	26	21.66
Marital status	Never married	5	4.16
	Married	103	85.83

	Widow/Widower	12	10
Occupation of tribal adult women	Maid	10	8.33
	Farm Labourer	82	68.33
	Labourer (for other work)	12	10
	Working in Self Help Group	9	7.5
	Business	4	3.33
	Private Job	3	2.5
Monthly income (Rs.) of the family	≤ 2,020	2	1.66
	2,021 – 6,059	36	30
	6,060 – 10,109	57	47.5
	10,110 – 15,159	16	13.33
	15,160 – 20,209	9	7.5
Socioeconomic status (SES)	Lower	51	42.5
	Lower Middle	25	20.83
	Middle	44	36.66
Type of diet	Vegetarian	50	41.66
	Eggetarian	19	15.83
	Non vegetarian	51	42.5

The table 1 outlines the demographic and socioeconomic profile of 120 tribal adult women. A majority (40%) are aged 21-25, 85.83% are married, and 68.33% work as farm labourers. Most families have a monthly income between 2,021–6,059 (30%), while 42.5% fall under the lower socioeconomic class. The data highlights their predominant engagement in labour-intensivework, low income levels, and economic challenges, with a notable portion (36.66%) in the middle socioeconomic status group.The majority of participants were non-vegetarian (42.5%), followed by vegetarian (41.66%), and eggetarian (15.83%).

Table 2: Prevalence of anaemia across different age groups *(n=120)*

Age Group	**Total**	**Anaemic No. (%)**	**Non-anaemic No. (%)**
21 to 25	48	27 (56.25)	21 (43.75)
26 to 30	46	23 (50)	23 (50)
31 to 35	26	14 (53.84)	12 (46.15)
Total	**120**	64 (53.33)	56 (46.66)

The table 2 shows that 53.33% of 120 women across all age groups were anaemic, with the highest prevalence in the 21-25 age group (56.25%), highlighting a significant health concern.

Table 3: Classification of anaemia prevalence across different age groups *(n=120)*

Age Group	**Severe Anaemia (Hb<8 gm/dl) No. (%)**	**Moderate Anaemia (Hb 8-10.9 gm/dl) No. (%)**	**Mild Anaemia (Hb 11-11.9 gm/dl) No. (%)**	**Non Anaemic (Hb ≥12 gm/dl) No. (%)**	**Total No. (%)**
21 to 25	4 (3.33)	22 (18.33)	1 (0.83)	21 (17.5)	48 (40)
26 to 30	4 (3.33)	18 (15)	1(0.83)	23 (19.16)	46 (38.33)
31 to 35	4 (3.33)	9 (7.5)	1 (0.83)	12 (10)	26 (21.66)
Total	**12 (10)**	**49 (40.83)**	**3 (2.5)**	**56 (46.66)**	**120 (100)**
χ^2=1.977; The p-value is 0.1597. significant at p < 0.01. (Not Statistically Significant)					

Table 3 presents the prevalence of anaemia across different age groups. Among the 120 participants, the majority (46.66%) were non-anaemic, while moderate anaemia was observed in

40.83%. Severe anaemia and mild anaemia were less common, affecting 10% and 2.5%, respectively. The chi-square test (χ^2=1.977, p=0.1597) indicates no statistically significant association between age groups and anaemia prevalence at $p < 0.01$.

Table 4: Prevalence of anaemia according to BMI classification*(n=120)*

BMI Classification (Kg/m2)	Severe Anaemia (Hb<8 gm/dl) No. (%)	Moderate Anaemia (Hb 8-10.9 gm/dl) No. (%)	Mild Anaemia (Hb 11-11.9 gm/dl) No. (%)	Non Anaemic (Hb ≥12 gm/dl) No. (%)	Total
Severely Underweight (15.0 - 16.0)	3 (2.5)	0 (0)	0 (0.5)	0 (0)	3 (2.5)
Underweight (16.01 - 18.49)	9 (7.5)	41 (34.16)	3 (2.5)	15 (12.5)	68 (56.66)
Normal Weight (Healthy weight) (18.5 - 24.99)	0 (0)	8 (6.66)	0 (0)	41 (34.16)	49 (40.83)
Overweight (25.0 - 30.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total	**12 (10)**	**49 (40.83)**	**3 (2.5)**	**56 (46.66)**	**120 (100)**

χ^2=71.549; The p-value is 0.0000. significant at $p < 0.01$. (Statistically Significant)

Table 4 indicates a significant association between BMI and anaemia among tribal adult women. Severely underweight and underweight women exhibit a higher prevalence of anaemia, while normal-weight women show lower rates. No cases of overweight were observed across any group, highlighting a strong link between lower BMI and increased anaemia in this population.

Table 5:Classification of anaemia prevalence according to socio-economic status*(n=120)*

Socio-economic Status	Severe anaemia (Hb<8 gm/dl) No. (%)	Moderate anaemia (Hb 8-10.9 gm/dl) No. (%)	Mild anaemia (Hb 11-11.9 gm/dl) No. (%)	Non anaemic (Hb ≥12 gm/dl) No. (%)	Total
Lower	8 (6.66)	23 (19.16)	2 (1.66)	18 (15)	51 (42.5)
Lower middle	3 (2.5)	10 (8.33)	0(0)	12 (10)	25 (20.83)
Middle	1 (0.83)	16 (13.33)	1 (0.83)	26 (21.66)	44 (36.66)
Total	**12 (10)**	**49 (40.83)**	**3 (2.5)**	**56 (46.66)**	**120 (100)**

χ^2=8.746; The p-value is 0.0031. significant at $p < 0.01$. (Statistically Significant)

Table 5 shows a statistically significant association between socio-economic status and anaemia prevalence (χ^2=8.746; p=0.0031). Lower socio-economic groups have a higher prevalence of severe and moderate anaemia, while middle-class groups exhibit lower anaemia rates and the highest proportion of non-anaemic individuals. This highlights the impact of socio-economic status on anaemia levels.

Table 6: Prevalence of anaemia based on dietary patterns*(n=120)*

Type of diet	Severe Anaemia (Hb<8 gm/dl) No. (%)	Moderate Anaemia (Hb 8-10.9 gm/dl) No. (%)	Mild Anaemia (Hb 11-11.9 gm/dl) No. (%)	Non Anaemic (Hb ≥12 gm/dl) No. (%)	Total
Vegetarian	8 (6.66)	23 (19.16)	2 (1.66)	17 (14.16)	50 (41.66)
Eggetarian	4 (3.33)	8 (6.66)	0 (0)	7 (5.83)	19 (15.83)
Non vegetarian	0 (0)	18 (15)	1 (0.83)	32 (26.66)	51 (42.5)
Total	**12 (10)**	**49 (40.83)**	**3 (2.5)**	**56 (46.66)**	**120 (100)**

χ^2=15.86; The p-value is 0.0001. significant at $p < 0.01$. (Statistically Significant)

Table 6 reveals a statistically significant association between dietary patterns and anaemia prevalence (χ^2=15.86; p=0.0001). Vegetarian and eggetarian diets are associated with higher rates of severe and moderate anaemia, while non-vegetarians exhibit the lowest anaemia prevalence and the

highest proportion of non-anaemic individuals, underscoring diet's role in anaemia risk.These findings suggest that dietary diversity influences anaemia risk, highlighting the need for tailored nutrition interventions.

Discussion

The demographic and socioeconomic profile of 120 tribal adult women from Akkalkuwa tehsil reveals critical factors contributing to the high prevalence of anaemia. A significant 78.33% of these women fall between 21 and 30 years of age, a period marked by increased nutritional needs due to menstruation, pregnancy, and lactation. This highlights the importance of addressing nutritional deficiencies in younger women. Marital status also plays a crucial role, with 85.83% of the participants being married, which adds nutritional demands due to pregnancy and childbearing. This increased demand, coupled with repeated pregnancies, contributes to higher risks of anaemia. Occupationally, 68.33% of the women work as farm labourers, a physically strenuous job often lacking adequate nutritional support and healthcare. The economic challenges faced by these women are compounded by their income levels; 30% of families earn between 2,021–6,059, and 42.5% of women belong to the lower socioeconomic class. These factors collectively contribute to the high anaemia rates observed. The findings show a strong and statistically significant correlation between socio-economic status and anaemia prevalence ($p < 0.01$). These low-income levels hinder access to iron-rich foods, healthcare, and dietary supplements, exacerbating anaemia prevalence. The data indicates that socio-economic status is a major determinant of anaemia, with women from lower economic backgrounds experiencing higher rates due to limited access to resources.

Research on the relationship between low socioeconomic status and anaemia prevalence among tribal populations highlights critical insights. For example, a study on the tribal population of North Kerala, India, highlighted a significantly high prevalence of anaemia, with an overall rate of 51%. Gender-wise, anaemia affected 33.3% of males and 64.6% of females, showcasing the heightened vulnerability of women in these communities. Women from lower socioeconomic backgrounds were particularly susceptible due to factors such as inadequate dietary diversity and limited access to healthcare services. These socio-demographic and cultural determinants were found to play a critical role in the high anaemia rates observed.The study underscored the critical role of targeted socioeconomic upliftment and nutritional interventions in reducing anaemia prevalence in tribal communities. These findings highlight the need for multi-dimensional approaches, combining economic, dietary, and health-focused measures, to address anaemia effectively in marginalized groups[25]. To effectively address anaemia in this population, interventions should focus on improving socio-economic conditions, enhancing nutritional education, and ensuring access to affordable healthcare and iron supplementation, particularly for vulnerable groups such as young women, farm labourers, and those from lower socioeconomic backgrounds.

The association between BMI and anaemia is another key finding of this research. Severely underweight and underweight women show significantly higher rates of anaemia, with a noticeable prevalence of both severe and moderate anaemia in these groups. This suggests that low BMI, which often reflects inadequate nutrition, plays a critical role in the susceptibility to anaemia among these women. In contrast, women with normal BMI have lower anaemia rates. These results highlight the importance of nutritional status in anaemia prevention. Poor dietary intake, insufficient caloric consumption, and lack of essential micronutrients contribute to lower body weight and anaemia. The research on the relationship between BMI and anaemia in tribal populations highlights key insights into nutritional and health outcomes. A study published in the Plos One Journal noted that tribal women with low BMI face a higher risk of anaemia due to inadequate caloric intake and micronutrient deficiencies, including iron and folate. It concluded that improving BMI through nutritional programs emphasizing balanced diets with essential macronutrients and micronutrients could significantly lower anaemia prevalence, addressing both energy deficits and micronutrient needs effectively[26]. This finding emphasizes the need for targeted nutritional

interventions, particularly for women with low BMI, to reduce the prevalence of anaemia in this population. Dietary patterns emerge as a significant determinant of anaemia.

The analysis indicates that vegetarian women have the highest rates of both severe and moderate anaemia, while non-vegetarian women show higher rates of being non-anaemic. This finding can be attributed to the lack of adequate iron intake from vegetarian diets, which may lack heme iron, the form more readily absorbed by the body. Non-vegetarian diets, rich in heme iron from animal sources, provide greater protection against anaemia.Diet diversity was inversely associated with prevalence of mild anaemia among non-pregnant women of reproductive age in rural India[27]. Given the cultural and regional dietary practices, where vegetarian diets may be predominant, the findings suggest the need for educational interventions that promote iron-rich food consumption, even within vegetarian dietary frameworks. Fortified foods, iron supplements, and improved dietary diversity should be considered to reduce anaemia prevalence among vegetarian women.

The statistical analysis reveals that several key variables, including BMI, socio-economic status, and dietary patterns, are significantly associated with anaemia prevalence. The chi-square value of 1.977 and p-value of 0.1597 for age-specific anaemia prevalence indicate that younger women, especially those aged 21–25, are at heightened risk. This could be due to increased nutritional demands during reproductive years, combined with the socio-economic hardships and labor-intensive work characteristic of this population.

Limitations and Future Scope

The study, conducted among tribal adult women in Akkalkuwa tehsil of Nandurbar district, provides valuable insights but has certain limitations. The cross-sectional design prevents establishing causality between socio-economic factors, BMI, dietary patterns, and anaemia prevalence. The sample size, although adequate for initial observations, restricts broader generalizations to tribal populations in other regions. Furthermore, the reliance on self-reported dietary intake data may have introduced recall bias, potentially impacting the accuracy of the findings.

Future research should include longitudinal studies to examine causal relationships and trends over time. Expanding the sample to other tribal communities can enhance representativeness. Exploring targeted interventions such as fortified food programs and socioeconomic initiatives, along with genetic and cultural influences on dietary habits, can refine strategies to combat anaemia in these vulnerable populations.

Conclusion

Overall, the findings point to a multifaceted interaction between socio-economic factors, nutritional status (as indicated by BMI), and dietary patterns, all of which are critical in determining anaemia prevalence among tribal women in Akkalkuwa tehsil. Addressing these factors through community-level health programs, nutritional education, and improving socio-economic conditions can be effective strategies to reduce anaemia in this vulnerable population. With a striking 53.33% prevalence rate, which exceeds the national average, the findings underscore the urgent need for targeted interventions. The data reveals that women from lower socioeconomic backgrounds are particularly vulnerable to anaemia, necessitating a special focus on this group in preventive and control measures.

The study, unique in its focus on this population, provides crucial baseline information that can inform policy makers and health administrators. To address the high anaemia rates, community-level health programs, enhanced nutritional education, and socioeconomic improvements are essential. The need for dietary diversification and increased intake of iron and micronutrients is critical, given the heightened nutritional demands of this demographic.

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