Original Article

A Cross-Sectional Study on Prevalence and Determinants of Anemia among Women of Reproductive Age in a Rural Community of West Bengal

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Abstract

Context: Anemia is a serious public health concern especially in women of reproductive age (WRA) as it causes a high burden of morbidity and mortality and persists through intergenerational cycle. As most of the risk factors are preventable, a thorough understanding of its risk factors is necessary to design better interventions. **Aims:** Current study aimed to estimate the burden of anemia as well as explore determinants of various grades of anemia among WRA in a rural area. **Settings and Design:** A community-based cross-sectional study was conducted among non-pregnant, non-lactating women of reproductive age in rural field practice area of All India Institute of Hygiene and Public Health. **Methods and Materials:** House to house visit was conducted for interviewing with pre-designed pre-tested questionnaire along with blood hemoglobin and anthropometric measurement. **Statistical Analysis Used:** Descriptive statistics and test of significance like multinomial logistic regression and Kruskal-Wallis test (with post-hoc) were used. **Results:** Majority (70.8%) of participants were anemic. Proportion of mild, moderate, and severe anemia were 24.16%, 37.5%, and 9.16%, respectively. Different levels of anemia were significantly associated with higher age, lower education, poor iron-rich food intake, lack of dietary diversity, and adiposity. Significantly low hemoglobin level in both underweight and obesity was noticed suggesting U shaped relationship between BMI and anemia. **Conclusion:** Periodic screening for anemia among WRA especially in both extremes of malnutrition, i.e., undernutrition and obesity should be considered at the policy level. Year-round behaviour change communication campaigns must be carried out for the promotion of necessary food groups in diet.

Keywords: Anemia, dietary diversity, hemoglobin, rural India, women of reproductive age

Introduction

Anemia is a clinical condition manifested by a decreased number of red blood cells or the hemoglobin concentration (Hb%) in blood beyond an optimum level. Due to decreased oxygen-carrying capacity, anemic persons suffer from fatigue, weakness and diminished physical, and cognitive performance.[1]

Women of reproductive age group (WRA) have a higher risk of complications of anemia especially during pregnancy and lactating period. Anemia in pregnant and lactating mothers can lead to high maternal and perinatal mortality as well as various morbidities such as low birth weight, premature delivery, childhood malnutrition, infection, etc., These conditions eventually lead to impaired physical, cognitive, motor, and scholastic development in the future. This impaired development

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Received: 19-06-2020 **Revised:** 08-09-2020
Accepted: 22-09-2020 **Published:** 30-11-2020

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/jfmpc.jfmpc_1209_20

How to cite this article: Ghosh P, Dasgupta A, Paul B, Roy S, Biswas A, Yadav A. A cross-sectional study on prevalence and determinants of anemia among women of reproductive age in a rural community of West Bengal. J Family Med Prim Care 2020;9:5547-53.

in turn causes a higher prevalence of infections and anemia in adolescents. Thus, anemia invokes an inter-generational cycle of illness-causing a major public health problem.[2]

Anemia in WRA is a major public health challenge worldwide. Globally one-third WRA suffers from anemia.[3] According to National Family Health Survey 4, 53% WRA in India were anemic.[4] Niti Ayog also reported 'Iron Deficiency Anemia' (IDA) causes a substantial physical and cognitive decline attributed to 1.18% GDP loss per annum in India.[5]

Higher prevalence of anemia in WRA is attributed to multifactorial etiology. WRA are vulnerable to anemia due to menstrual blood loss. Menstrual irregularities, malnutrition, diet deficient in iron, vitamin B12, folic acid, etc., helminthic infestations, hemoglobinopathies, malaria, tuberculosis, and other chronic infections can precipitate anemic condition. Most of these risk factors are preventable.[6]

Government of India adopted a number of strategies to control anemia and its consequences which is intensified after the launch of Anemia Mukt Bharat under "POSHAN (PM's Overarching Scheme for Holistic Nourishment) Abhiyaan" in 2018. This initiative targeted to reduce prevalence of anemia by 3% per year in WRA by 2022.[7]

Severity of anemia may be attributed to various risk factors at a different level. This can impose a challenge to control different grades of anemia through ongoing "one fits for all" strategy. Most of the studies were interested with prevalence of anemia in pregnancy and childhood. But a handful studies were conducted to identify prevalence and predictors of anemia in WRA especially in rural India. Moreover, anemia is undetected in this age group due to apparently healthy conditions and lack of awareness associated to it. So, community-based approach to detect anemia is the need of the hour to estimate its actual burden. In this context, the present community-based study was conducted to estimate the burden of anemia as well as elicit determinants of various grades of anemia in WRA in a rural area of West Bengal.

Subjects and Methods

Community-based cross-sectional study was conducted from June to September 2019 in the rural field practice area of All India Institute of Hygiene and Public Health (AIIH&PH) at Singur. Study population was non-pregnant, non-lactating (NPNL) women of reproductive age group (15–49 completed years). Critically ill women were excluded.

Sampling

National Family Health Survey 4 showed 63.2% of WRA at Hooghly district in West Bengal were anemic.[8] Based on prevalence $P = 0.632$, $Q = 1 - P = 0.368$, 95% confidence interval $Z = `1.96$; Relative error (L) = 0.2 and according to the formula $\{Z^2 \times (P \times Q)\}/L^2$ estimated sample size was 56. Cluster sampling (20 clusters) was used. Multiplication with design effect 2 was done. Six WRA per cluster $\{(56 \times 2) \div 20 \approx 6\}$ were selected. The final sample was 120.

Out of 64 villages in the study area, 20 villages were selected by probability proportional to population size. After going to the centre of each village, the first household was chosen randomly in a random direction. Subsequent households were visited continuously till 6 WRA covered. In case a household had more than one WRA, women having birthday closest to the date of the survey were selected.

Data collection

After taking informed written consent, interviews were conducted using a pre-designed, pretested schedule including Minimum Dietary Diversity for Women (MDD-W) tool. Height and weight were measured using standard method.[9] Body fat % was measured using body Fat/Hydrating Scales – "Eagle EEF 2003A" by E. G. Kantawalla Pvt Ltd.[10] Capillary blood was drawn aseptically and hemoglobin was measured using digital hemoglobinometer Mission® by ACON laboratories, USA.[11] Biomedical waste generated was disposed of in nearby PHC as per standard procedure.[9] Confidentiality was maintained throughout the process. Ethical approval was taken from institutional ethics committee of AIIH&PH.

Data analysis

Data were analysed using Microsoft Excel 2016 and Statistical Package for the Social Sciences (SPSS for Windows, version 16.0, SPSS Inc., Chicago, USA) software version 16. Descriptive and inferential statistics as Multinomial logistic regression, Kruskal Wallis test with post-hoc analysis was conducted. Level of significance was taken in 95% confidence interval (P value < 0.05).

Biologically plausible covariates showing significant association in bivariate model were selected in the final multivariate multinomial logistic regression model.

Operational definition

Anemia

Hemoglobin level (Hb%) below 12 gm% was defined as Anemia. Categorisation of anemia into mild (Hb% = 11 to 11.9), moderate (Hb% = 8 to 10.9) and severe (Hb% < 8) was done.[12]

Menstruation abnormalities

Menorrhagia was defined as excessive menstrual bleeding in amount (>80 ml) or duration (>7 days) or both at normal intervals. Polymenorrhea was defined as menstrual bleeding with a reduced interval of less than 21 days. Oligomenorrhea was denoted as menstrual bleeding with an interval of more than 35 days.[13]

Dietary diversity

Dietary diversity was assessed using MDD-W tool developed by Food and Agriculture Organization (FAO), United Nations. Out

of 10 food groups, consumption of minimum 5 groups were taken as minimum dietary diversity.[14]

Iron rich food

Dark green vegetables, pulse and legumes, flesh-food were considered as iron-rich food.[2]

Obesity

According to WHO cutoffs, body mass index (BMI) was categorized in underweight (<18.5 kg/m^2), normal (18.5 – 24.9 kg/m^2), Overweight (25 – 29.9 kg/m^2) and Obese (>30 kg/m^2) groups.[15]

Body fat percentage

Adiposity was considered in > 35% body fat percentage.[16]

Result

In the present study, the mean (SD) age of the study population was 31.9 (±8.4) years. Mean (SD) years of schooling was 8.1 (± 4) years whereas 10.8% of participants had no formal education. Most of the study populations (79.2%) were homemakers. Mean (SD) per capita income was ₹ 1668.4 (±963.8). Almost half (48.3%) belonged to Class IV socioeconomic (B. G. Prasad scale 2019) group. [Table 1]

Anemia

Majority (70.8%) were anemic. Proportion of mild, moderate and severe anemia were 24.16%, 37.5% and 9.16% respectively. [Figure 1] Mean (SD) hemoglobin level of participants was 10.8 ± 1.9 gm%. [Table 2]

Reproductive health

Majority (85.8%) had history of pregnancy in past. Out of these 103 women, one-third (29.1%) consumed less than 100 iron tablets in the last pregnancy. Nearly half (55%) had 2 or more pregnancy among which (39 out of 66), majority (59.1%) had a spacing of minimum 36 months.

Majority (82.5%) had no menstrual complaints at present. Whereas some of them were suffering from menorrhagia (19.2%), oligomenorrhea (5.3%) and polymenorrhea (4.3%). [Table 1]

Behavioural profile

Almost half of them (58.3%) had iron-rich food in their daily diet. Minimum dietary diversity (MDD-W) was present in 65.8% subjects with mean (SD) score of 5.4 (±1.5). More than one-third (35%) were practicing barefoot walking even in outdoor. [Table 1]

Nutritional profile

Malnutrition in terms of underweight, overweight and obese were present in 6.7%, 36.6% and 24.2% study subjects. According to body fat percentage, proportion of adiposity were 21.7%. [Table 1]

Association between anemia and covariates

In bivariate multinomial model, different grades of anemia showed significant association with age, educational attainment, intake of iron-rich food, minimum dietary diversity score, adiposity (body fat%) and footwear use in outdoor.

In adjusted multinomial logistic regression model, all of these covariates except footwear use retained significant association. In comparison to non-anemic persons, mild anemia was associated with diet deficient of iron rich food.(AOR = 4.78, P = 0.04) and adiposity (AOR = 3.8, P = 0.03) Whereas, increasing age (AOR = 1.07, P = 0.04), education level below middle school (AOR = 3.85, P = 0.03), diet lack in iron rich food (AOR = 6.44, P = 0.009), decreasing MDD-W score (AOR 1.6, P = 0.04) were found significant predictors of moderate

Table 1: Distribution of Study Participants According to Sociodemographic, Behavioural and Reproductive Profile (*n*=120)

Variables (Characteristics)	*n* (%)
Sociodemographic characteristics	
Age in years	
15-25	30 (25%)
26-35	42 (35%)
36-49	48 (40%)
Educational Level	
Illiterate	13 (10.8%)
Primary and below	28 (23.3%)
Middle school	29 (24.2%)
Secondary and above	50 (41.7%)
Occupation	
Homemaker and student	104 (86.7%)
Work with pay	16 (13.3%)
Menstrual health (Multiple Response)	
Normal	99 (82.5%)
Menorrhagia	23 (19.2%)
Polymenorrhea	6 (5.3%)
Oligomenorrhea	5 (4.3%)
Nutrition, Diet and Personal Hygiene	
Underweight	8 (6.7%)
Normal	39 (32.5%)
Overweight	29 (24.2%)
Obese	44 (36.6%)
Obese (based on body fat)	26 (21.7%)
Have minimum diverse diet (MDDW)	79 (65.8%)
Intake of iron rich food	70 (58.3%)
Footwear use outside house always	78 (65%)

Table 2: Distribution of hemoglobin level in different BMI groups (*n*=120)

Hemoglobin (gram%)	Underweight	Normal	Overweight	Obese	Total
Mean	8.42	11.42	11.2	10.02	10.8
Median‡	8.6	11.5	11.7	10.00	11.15
SD	1.53	1.5	1.75	2.06	1.9

‡Kruskal wallis test revealed difference in median Hemoglobin level across different BMI groups (P<0.001). *Post hoc* analysis using Bonferroni correction showed significant difference of Hb% level between underweight and normal (P=0.001), underweight and overweight (P=0.002), normal and obese (P=0.027), while difference between underweight and obese (P=0.37), obese and overweight (P=0.064) and normal and overweight (P=1.00) were not statistically significant

Table 3: Multinomial Multivariable Logistic Regression model showing associates of mild, moderate and severe anemia in comparison to Non-anemic participants (*n*=120)†

Variables	Mild anemia (AOR, *P*)	Moderate anemia (AOR, *P*)	Severe anemia (AOR, *P*)
Age ↑	1.03, 0.47	1.07, 0.04*	0.95, 0.39
Educational attainment			
Below middle school	1.25, 0.74	3.85, 0.03*	4.56, 0.12
Middle school passed	1	1	1
Footwear use practice			
Yes	1	1	1
No	1.38, 0.61	2.26, 0.19	1.59, 0.62
Minimum Dietary Diversity Score↓	1.28, 0.28	1.6, 0.04*	18.2, 0.002*
Iron rich food intake			
Yes	1	1	1
No	4.78, 0.04*	6.44, 0.009*	1.14 (0.74)
Adiposity (Body Fat %)			
Present	3.8, 0.03*	1.05, 0.93	14.08, 0.016*
Absent	1	1	1

†Goodness of fit of this model- in Pearson Chi-square test - *P* is 0.165, Deviance Chi-square test- *P*=1.0. Nagel Kerke R^2 is 0.53, Cox and Snell R^2 is 0.49 and McFadden R2 is 0.26. *$P<0.05$

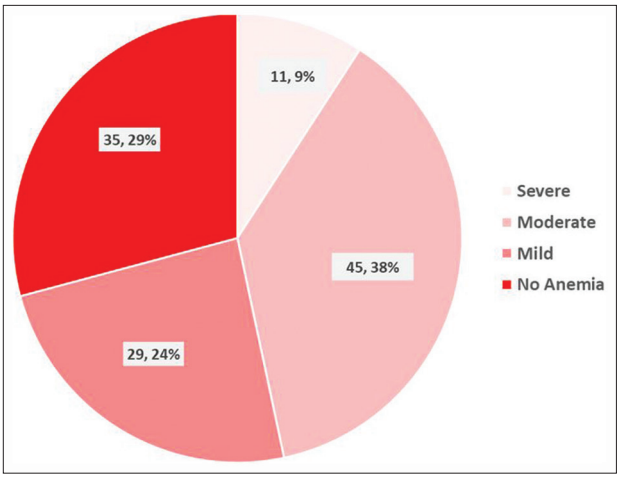

Figure 1: Distribution of study population according to different categories of anemia

anemia. Risk of severe anemia was significantly higher in women with low MDD-W score (AOR = 18.2, *P* = 0.002) and adiposity (AOR = 14.08, *P* = 0.016) in comparison to non-anemic individuals. Model fitting was good which was evident from retained null hypothesis in Pearson Chi Square (*P* = 0.165) and Deviance Chi square test (*P* = 1.00). Adequacy of regression fit was assessed using proportion of total variance explained by the model i.e., coefficient of determination.(Nagel Kerke $R^2 = 0.53$, Cox and Snell $R^2 = 0.49$ and McFadden $R^2 = 0.26$).[Table 3]

BMI was not found significantly associated with different grades of anemia. However, we found all (100%) underweight and three-fourth (75.9%) of obese participants had anemia. Thus, median hemoglobin levels were compared across various BMI categories and found low median hemoglobin levels in underweight (8.6 gram%) and obese group (10 grams%) in comparison to normal and overweight categories (11.5 and 11.7 gram%). As hemoglobin level was not normally distributed (Kolmogorov − Smirnov test, *P* value = 0.003), Kruskal Wallis test was conducted and this differential hemoglobin level was found statistically significant (*P* value < 0.001). Post hoc analysis showed that underweight and normal (*P* = 0.001), underweight and overweight (*P* = 0.002) and normal and obese (*P* = 0.027) categories significantly differed in median hemoglobin level, while no such difference was found between underweight and obese (*P* = 0.37), obese and overweight (*P* value 0.064) and normal and overweight (*P* = 1.00) categories**.** [Table 2]

Discussion

Prevalence of anemia

Current study showed the proportion of anemia among NPNL women of reproductive age as 70.8% which was comparable with NFHS 4 finding in rural West Bengal (64.3%) as well as Hooghly district (63.2%).[8] Similar proportion of anemia was found by Pal A *et al.* in West Bengal (66.87%), Little M *et al.* in South India (57.2%), Panigrahi *et al.* in Odisha (60.8%) and Chowdhury R *et al.* in Delhi.[17–20] Panyang *et al.* showed almost 100% WRA in a tea garden community in Assam had moderate to severe anemia. This exorbitant prevalence of anemia was attributed to high proportion (23.9%) of hemoglobinopathies in that population.[21]

However, proportion of mild, moderate and severe anemia in our study were 24.16%, 37.5% and 9.16% respectively. That was inconsistent with NFHS 4 data for mild, moderate and severe anemia (48.9%, 12.8% and 0.8%).[8] The prevalence of mild, moderate and severe anemia was 39.4%, 12.1%, and 1% respectively in South-East Asian countries.[22] Panigrahi A *et al.* found proportion of mild, moderate and severe anemia (39.6%, 20% and 1.2%).[19] This differential finding was probably due to separate cut off hemoglobin levels for mild, moderate and severe anemia (10-11.9, 7-9.9 and <7 gram%). Whereas we followed hemoglobin cut off recommended by WHO for this study.[12]

Little M *et al.* showed proportion of mild, moderate and severe anemia in Krishnagiri, Tamil Nadu was 18%, 35.9% and 3.4% respectively which was comparable to current study.[18]

Pal A *et al.* in rural West Bengal found 11.04% women as severe anemic similar to our study.[17]

Factors associated with anemia

Current study observed significant association of anemia with a lack of dietary diversity and deficiency of iron-rich food in the diet. It was consistent with almost all the studies conducted among WRA regarding determinants of anemia in recent times.[17,19,23] It indicated that the most probable cause of anemia among this population was nutritional in origin. Due to lack of resources other biochemical parameters like serum iron, serum ferritin, serum transferrin receptors, serum folate, serum vitamin B12 etc., could not be assessed to confirm its nutritional etiology. High Performance Liquid Chromatography (HPLC) was also not conducted to rule out hemoglobinopathies.

Increased risk of moderate anemia was significantly associated with lower level of educational attainment. Findings from NFHS 4 and other studies also revealed association between anemia and poor educational level.[4,19,22,24] Increase in education level may improve their cognition regarding environmental sanitation, personal hygiene and a balanced diet and provide protection against anemia. In a recent study by Chowdhury R *et al.*, they showed a decreased risk of moderate to severe anemia in those who completed at least secondary education among nonpregnant married women aged 18 − 30 years in low- to middle-income urban neighborhoods in Delhi.[20]

Increasing age was found to be a significant predictor of moderate anemia in our study which was corroborated with findings of Panigrahi A *et al.* and Ganapathi C *et al.*[19,23] Decreased hematopoiesis in response to hormonal stimulus was noticed in advanced age which might be precipitated by dietary insufficiency.[25] However, Sinha NK *et al.* showed that younger age group was more vulnerable to anemia in a study at Jangal-Mahal of West Bengal.[26] Similar association was found in a secondary data analysis in all South-East Asian countries.[22] This discrepancy might be attributed to higher number of early-age conception in that population leading to anemia.

No significant association was found between abnormal menstrual bleeding and anemia, unlike other studies.[19,23] Prevalence of menstrual problems was relatively low compared to those studies and that may impede the association of heavy menstrual bleeding with anemia.

Walking barefoot is a known risk factor of soil-transmitted helminth (STH) infection and anemia.[23,27,28] Though the current study found significant association between footwear use and anemia in unadjusted model but this association was flattened in the multivariable model. Such finding indicated that education probably had a confounding effect on footwear use and anemia. Recent intensified campaigns on social and behaviour change communication (SBCC) through Swachh bharat mission and poshan abhiyan might have a role in decreasing prevalence of bare-foot walking and STH infection. But current study lacked microbiological evidence to claim it. Women from the poorest wealth quintile, women without toilet facilities and improved water sources were more vulnerable to anemia in South-East Asia.[22]

Existing literature suggested that hemoglobin levels had a proportional relationship with BMI.[17,29] But the current study revealed significantly low hemoglobin levels in both spectrum of malnutrition, i.e., underweight and obesity suggestive of 'U' shaped relationship. Underweight WRA might lack an adequate balanced diet leading to both anemia and protein-energy malnutrition. Malabsorption, poor immunity and recurrent infections might have an incremental role in that. On the contrary, there was an increasing trend of intake of energy-dense but nutrient-poor diet especially in low- and middle-income countries which could be manifested as anemia in obese persons as a hidden hunger.[30] Previous studies showed that the risk of moderate to severe anemia was low among overweight women and high in underweight women.[20]

Moreover, up-regulated hepcidin and lipocalin-2 expression were associated with high adiposity causing diminished iron absorption and increased iron sequestration from reticuloendothelial macrophages to adipocytes which supported the significant association of body fat percentage with both mild and severe anemia in the present study.[31-35] However current study lacked corroborative evidence of serum hepcidin, lipocalin-2 and ferritin level to claim this pathway.

The use of probability sampling and multinomial multivariable regression was a major strength of this study which improved external generalizability as well as allowed to identify predictors of different grades of anemia. Being a population-based survey with point of care testing current study removed chance of underreporting in asymptomatic mild cases. The use of minimum dietary diversity scale designed for women by FAO allowed the researchers to measure dietary diversity quantitatively which was lacking mostly in previous studies. However, the cross-sectional design of present study could not elicit the direction of causality between anemia and its attributes.

High prevalence of anemia among WRA residing in rural villages of Singur can be considered as a severe public health problem.[36] WRA in rural area are best accessed through primary care settings and interventions through grass root level cadres and this will eventually mitigate the problem of anemia burden. It is also crucial to appreciate that even mild anemia may be an indication of a serious underlying condition.[37] This article will build evidence in anemia and its preventive measures as they pertain to the primary health care physicians. Multi-dimensional etiologies of different levels of anemia in WRA elucidated in this study suggest that multipronged intensified approach for prevention and control of anemia is highly needed. Periodic screening for the detection of anemia among WRA especially in both extremes of malnutrition, i.e., undernutrition and

obesity should be considered at policy level. Policy-driven year-round intensified SBCC campaign must be carried out for the promotion of necessary food groups in diet of WRA and thereby ensure dietary diversity. Intensified efforts for anemia prevention among WRA in order to break the intergenerational cycle and ensure healthy life through the existing nationwide robust programme – 'Anemia Mukt Bharat' will go a long way to tackle anemia in India.

Acknowledgements

We want to convey our gratitude to Director of All india Institute of Hygiene and Public Health to permit us to conduct this study. We also acknowledge the support of health functionaries of Rural Health Unit and Training Centre, Singur under AIIH&PH for their untiring support.

Key messages

- Anemia still has high prevalence among women of reproductive age in rural India.
- Anemia can be prevented by eliminating some modifiable risk factors like low education, lack of iron-rich food, and absence of diversity in diet.
- There may be an association of adiposity with anemia.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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