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Prevalence of Anemia and Its Determinants Among Nonpregnant and Pregnant Women in India

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This study investigates the severity and distribution of anemia among nonpregnant and pregnant women aged 15 to 49 years in urban and rural sectors of 26 states in India and its association with certain economic and biosocial factors. A national survey was conducted to collect data on hemoglobin, height, weight, and certain economic and biosocial factors of 72 660 nonpregnant and 5619 pregnant women. Nonpregnant women aged less than 25 years are most affected by anemia. Women's education and standard of living in the households have a vital role in reducing anemia. Urban and well-nourished women also suffer less from anemia. The severity of anemia is higher among pregnant than nonpregnant women. Efforts must be made to educate women and enhance their level of economic status so that the prevalence of anemia can be reduced substantially.

Keywords: anemia; BMI; economic and biosocial factors; hemoglobin; logistic regression; nonpregnant and pregnant women; states in India

Introduction

Anemia is a major public health problem worldwide. Around 2 billion people, 30% of the world's population, are affected by anemia,[1] and the majority of them are from the developing world. It is reported that 56% of pregnant women in developing countries and 18% in developed countries are anemic.[2] For nonpregnant women, the estimated prevalence is 43% and 12% in developing and developed countries, respectively.[2] The causes of anemia are manifold, but iron deficiency is by far the most important cause of nutritional anemia worldwide.[3]

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Anemia is the most common nutritional disease in developing countries. It mostly affects women of reproductive age and preschool children. Anemia has detrimental physical, social, and economic effects. Even mild to moderate anemia affects the sense of well-being, resulting in fatigue and stress, consequently reducing productivity and work capacity. Severe anemia that occurs in developing countries is a major cause of maternal mortality and morbidity.[2] Anemia is attributed to be a direct or indirect cause of about 26% of maternal deaths in India. Severe anemia may cause cardiac failure and death, whereas chronic anemia is considered to be contributory to problems of hemorrhage and infection.[4] Anemia during pregnancy is also associated with increased risk of intrauterine growth retardation, premature delivery, and low birth weight, resulting in an increase in perinatal mortality.[5,6]

Anemia (defined as the lack of sufficient hemoglobin [Hb] concentration in the blood) in many developing countries, is primarily a result of the lack of bioavailable dietary iron.[7] Both nutritional and nonnutritional factors may cause anemia. The most common nutritional cause is iron deficiency. Iron deficiency anemia (IDA) results from a combination of several factors: (1) inadequate iron intake and/or low dietary availability; (2) high physiologic demands in early childhood and pregnancy, and periods of rapid growth such as adolescence; (3) chronic iron losses from parasitic infections such as hookworm and schistomiasis; and (4) deficiencies of vitamin B12, folic acid, and vitamin A.[8-10] Nonnutritional causes of anemia include malaria, hemorrhage, inherited disorders, and various chronic diseases.[11] Thalassemic patients have a tendency to become anemic. But anemic persons need not be thalassemic. In fact, there is a positive association between β-thalassemia and prevalence of anemia.[12] The average incidence of the β-thalassemia trait in India is 3.3%, with 1 to 2 per 1000 couples being at risk of having affected offspring each year.[13] About 10 000 children with thalassemia major are born annually in India, constituting about 10% of the total number born in the world each year.[14] In India, the prevalence of thalassemia is very high among certain communities like Punjabi, Sindhi, Gujarati, Bengali, Parsee, and Lohana, and in certain tribes; that is, it is more common in the northern, western, and eastern parts, whereas the incidence is much less in the south of India.[15] The normal physiologic iron losses among menstruating women and the substantial increase in iron requirements during the second and third trimesters of pregnancy make it inevitable for many women to develop anemia if they do not receive supplemental iron.[16] In developing countries, anemia is often aggravated by repeated and closely spaced pregnancies as well as by intestinal parasites, mostly hookworm.[17] Iron balance is dependent on the body's iron stores, absorption, and losses. At least two thirds of body iron is functional iron, found mainly as Hb circulating in the blood cells. Most of the remaining is storage iron, mainly in the form of serum ferritin, to be mobilized when needed.[18]

There are 3 major stages in the development of iron deficiency.[19] Iron depletion is a reduction in the serum ferritin level, with no evidence of functional consequences;[20,21] iron-deficient erythropoiesis occurs when the needs of the erythroid marrow for iron are no longer met, with a subsequent rise in erythrocyte protoporphyrin and serum transferring receptor level; and finally, IDA is the most severe form associated with functional consequences. IDA is diagnosed when the Hb concentration is lower than the level considered normal for the person's age, gender, and physiological status (ie, below a statistically defined threshold of 2 standard deviations from the mean for a healthy population).[22] The restriction in Hb production causes distortion of erythrocytes with microcytosis and hypochromia. Well-documented consequences of anemia include diminished learning ability, reduced work capacity, increased morbidity from infections, and greater risk of death associated with pregnancy and childbirth.[23] Infants born to anemic mothers are more predisposed to low birth weight and prematurity.[24,25]

The aim of the present study is to provide detailed population-based data to establish the frequency, severity, and distribution of anemia among Indian women aged 15 to 49 years at the national level, by urban and rural areas and by different states and regions, and to assess the trend and causes of prevalence of anemia and compare this with findings from other studies.

Materials and Methods

Data

Demographic and health survey data from 26 states of India, which were collected during the Second National Family Health Survey 1998/99[26] by the International Institute of Population Sciences and ORC Macro 2000, have been used for the present analysis. These data have been published and provided the sample for the present analysis. They include Hb, height, weight, and economic and biosocial data on 78 279 (72 660 for nonpregnant and 5619 for pregnant) women aged 15 to 49 years.

Data Collection

The target sample size of women in each state was set considering mainly the size of the state and the resources available for the survey. The urban and rural samples within each state were drawn separately and to some extent proportionally to the size of the urban and rural populations. The sample design was the same for each state. A 2-stage sample design was taken in rural areas. The primary sampling units were villages, taken with probability proportional to size (PPS) at the first stage. If the number of households in the village was more than 300, it was divided into 3 or more segments, and 2 segments were selected randomly using the PPS method. In the second stage, households to be interviewed were selected with equal probability from the household list in each selected enumeration area using systematic sampling. In the urban area, the National Sample Survey (NSS) blocks served as the sampling frame. The cities and towns were divided into 2 strata: self-selected cities and other towns. Self-selected cities had selection probability 1. In the self-selected cities, NSS blocks were first selected using PPS and then households were selected using systematic sampling. In the remaining urban areas, first towns were selected using PPS, then NSS blocks were selected using PPS, and finally, households were selected systematically from each selected block.

The levels of Hb in adult women were estimated using the HemoCue system. This system uses a single drop of blood from a finger prick, which is drawn into a cuvette and then inserted into a portable, battery-operated instrument. The Hb concentration appeared on a digital screen. Before the anemia testing was undertaken in a household, the respondent was asked to sign a consent form. Weight was measured using a solar-powered digital scale with an accuracy of ±100 grams. Height was measured using an adjustable wooden measuring board to the nearest 0.1 cm in a field situation. The same team gave training to the resource persons, who in turn trained the investigators. Thus, we may assume that uniform procedure was adopted for estimating the Hb level and other parameters in all the 26 states in India. Economic and biosocial data were collected using a structured schedule.[26]

Data Analysis

Hemoglobin levels among women have been classified on the basis international standard[2] as follows for nonpregnant women: normal, ≥12.0 g/dL; mild, 10.0 to 11.9 g/dL; moderate,

7.0 to 9.9 g/dL; and severe, <7.0 g/dL. For pregnant women, the values are as follows: normal, ≥11.0 g/dL; mild, 10.0 to 10.9 g/dL; moderate, 7.0 to 9.9 g/dL; and severe, <7.0 g/dL. Any anemia is defined as the concentration of Hb level <12.0 g/dL in nonpregnant women and <11.0 g/dL in pregnant women.

Socioeconomic and biosocial factors, including age of the women; their religion; ethnicity; place of residence; educational level; occupational type; standard of living index in household (household SLI), which was classified as low, medium, and high as per score obtained; and nutritional status of the women (<18.5 kg/m^2 BMI classified as undernutrition) have been considered in the present analysis. The methods of data collection and their classification have been published in the National Family Health Survey-II report.[26]

For the present analysis, the distributions of the prevalence of anemia in both nonpregnant and pregnant women have been shown in terms of the 26 states as well as in terms of the different economic and biosocial factors. Logistic regression was done to determine the association between various economic and biosocial variables as a function of the anemic status of pregnant and nonpregnant women. Anemic women were coded as 1 and nonanemic women as 0. We used SPSS version 10 for analysis.

Results

Table 1 shows the zonewise and statewise distributions of mean Hb levels as well as the prevalence of anemia among nonpregnant Indian women. At the national level, the mean Hb concentration for nonpregnant women is 11.78 g/dL; 49.6% of women are anemic (Hb < 12.0 g/dL) and 1.4% are severely anemic (Hb < 7 g/dL). The lowest mean Hb level is observed in the Eastern zone (11.32 g/dL) of India. The eastern zone also has the highest prevalence of anemia (63.2%) compared with other zones at the national level. The second lowest mean Hb concentration was seen in the northeastern zone (11.71 g/dL), followed by the central zone (11.79 g/dL). On the other hand, the mean Hb concentration is higher in the western, southern (11.91 g/dL in each state), and northern zones (12.0 g/dL) than the national level. But the prevalence of severe anemia is higher in the western (1.9%) and southern (2.0%) zones compared with the total prevalence in India. Besides these, Assam (10.98 g/dL) is the worst state in India as per mean Hb level and also has the highest (69.0%) percentage of anemic women. The highest mean Hb level is seen in Kerala (12.85 g/dL) along with the lowest (22.4%) prevalence of anemia. Women from Manipur, Nagaland, Goa, and Himachal Pradesh are observed to be less anemic (less than 40%) compared with those from other states in India. The maximum prevalence of severe anemia is seen in Gujarat (2.4%) followed by Meghalaya, Andhra Pradesh, Karnataka, and Tamil Nadu (all 2.3%).

The percentage distributions of the different levels of anemia among nonpregnant women as a function of economic and biosocial factors (Table 2) shows that anemia is more prevalent in younger women. Hindu women suffer more (51.8%) than other religious groups. Scheduled tribes (STs) are the main victims of anemia (57.3%) when compared with other ethnic groups, and 51.9% of rural women suffer from anemia, as against 44.6% of their urban counterparts. Level of education plays a significant role in the prevalence of anemia: that is, illiterate women suffer more from anemia (54.5%) than those who studied up to primary, secondary, and higher secondary levels. More women engaged in household work (48.8%), agricultural work (53.3%), and manual labor (51.1%) suffer from anemia compared with women who are not engaged in any work or engaged in sedentary types of work. Higher prevalence of anemia has also been noticed among women with low household SLI (59.5%) and among undernourished mothers (55.7%). The contingency χ^2 test on the number of

Table 1. Zonewise and Statewise Distribution of Mean Hb and Percentage Distribution of Anemia Among Nonpregnant Women

	Hb Level		Percentage Distribution of Anemia					
Zones/States	n	Mean	SD	Severe	Moderate	Mild	Any Anemia	Normal
North-Eastern	8541	11.71	1.76	0.9	14.0	37.6	52.5	47.5
Arunachal Pradesh	914	11.82	1.45	0.2	8.0	48.5	56.7	43.3
Assam	2457	10.98	1.50	0.8	22.5	45.7	69.0	31.0
Manipur	1187	12.74	1.64	0.6	5.1	20.1	25.8	74.2
Meghalaya	642	11.22	2.02	2.3	24.5	34.3	61.1	38.9
Mizoram	899	12.07	1.67	0.7	9.0	34.8	44.5	55.5
Nagaland	632	12.54	1.78	0.5	7.8	23.3	31.6	68.4
Sikkim	878	11.84	1.84	1.5	12.3	35.2	49.0	51.0
Tripura	932	11.51	1.61	1.4	12.3	44.5	58.2	41.8
Eastern	13175	11.32	1.63	1.5	16.0	45.7	63.2	36.8
Bihar	5672	11.24	1.65	1.4	17.9	45.4	64.7	35.3
Orissa	3941	11.38	1.61	1.6	14.3	46.4	62.3	37.7
West Bengal	3562	11.39	1.61	1.4	14.8	45.8	62.0	38.0
Central	10644	11.79	1.84	1.2	13.3	36.1	50.6	49.4
Madhya Pradesh	5942	11.76	1.83	1.0	13.4	37.7	52.1	47.9
Uttar Pradesh	4702	11.82	1.87	1.4	13.2	34.1	48.7	51.3
Western	8770	11.91	1.91	1.9	12.1	30.7	44.7	55.3
Goa	1109	12.24	1.68	0.9	7.8	27.7	36.4	63.6
Gujarat	3252	11.88	2.04	2.4	13.3	30.1	45.8	54.2
Maharashtra	4409	11.86	1.85	1.7	12.4	31.9	46.0	54.0
Northern	17386	12.00	1.82	1.2	11.4	31.3	43.9	56.1
Haryana	2536	11.86	1.89	1.5	13.4	31.6	46.5	53.5
Himachal Pradesh	2744	12.47	1.64	0.1	7.2	25.5	32.8	67.2
Jammu	2377	11.84	1.76	1.1	12.5	34.7	48.3	51.7
New Delhi	1918	12.04	1.70	1.4	9.1	30.5	41.0	59.0
Punjab	2425	12.08	1.82	0.7	11.8	29.2	41.7	58.3
Rajasthan	5386	11.83	1.88	1.7	12.6	34.2	48.5	51.5
Southern	14144	11.91	1.91	2.0	11.9	30.5	44.4	55.6
Andhra Pradesh	3648	11.68	1.95	2.3	14.6	33.0	49.9	50.1
Karnataka	3777	11.96	1.99	2.3	12.7	27.0	42.0	58.0
Kerala	2568	12.85	1.47	0.5	2.5	19.4	22.4	77.6
Tamil Nadu	4151	11.48	1.84	2.3	14.6	38.4	55.3	44.7
India	72660	11.78	1.83	1.4	13.0	35.2	49.6	50.4

NOTES: Hb = hemoglobin; SD = standard deviation.

cases as a function of the different economic and biosocial factors mentioned above was carried out and found to be significant at the 1% level for all the cases.

The Hb levels of the pregnant women also present a similar picture (Table 3). At the national level, the mean is found to be 10.93 g/dL, which is lower than that for nonpregnant women. But the prevalence of anemia (Hb < 11.0 g/dL) in pregnant women (47.5%) was slightly lower than that in nonpregnant women. Here also the lowest mean Hb concentration is seen in the eastern zone (10.66 g/dL), which is consistent with the highest

Table 2. Categorywise Distribution of Different Levels of Anemia With Economic and Biosocial Factors Among Nonpregnant Women

Factors	n	Percentage Distribution of Anemia				χ^2 *P* Value
		Severe	Moderate	Mild	Normal	
Age group (years)						
Less than 25	16 199	1.5	15.1	37.6	45.8	209.611,[a] df = 9
25-34	27 771	1.4	12.5	35.0	51.2	
35-44	21 312	1.4	12.6	34.0	51.9	
45 and above	7378	1.5	11.3	34.0	53.2	
Religion						
Hindu	56 910	1.5	13.2	36.0	49.2	213.049,[a] df = 9
Muslim	8083	1.2	13.1	33.8	51.8	
Christian	4098	1.1	10.8	28.4	59.6	
Others	3569	1.2	11.7	32.1	55.0	
Ethnicity						
SC	12 425	1.8	14.5	37.4	46.3	560.512,[a] df = 9
ST	8777	1.6	16.1	39.6	42.7	
OBC	21 561	1.6	13.0	35.5	49.9	
None of the above	29 897	1.1	11.5	32.7	54.7	
Residence						
Urban	22 760	1.2	10.7	32.7	55.4	370.570,[a] df = 3
Rural	49 900	1.5	14.1	36.3	48.1	
Education						
No education	35 574	1.8	15.3	37.4	45.5	1092.534,[a] df = 9
Primary	12 740	1.5	12.9	35.2	50.4	
Secondary	17 754	1.0	10.4	32.7	55.9	
Higher	6592	0.4	7.7	29.6	62.3	
Occupation						
Household work	45 800	1.2	12.7	35.0	51.2	297.046,[a] df = 9
Professional/sales/service	4144	1.1	9.8	29.9	59.1	
Agriculture	16 917	2.1	14.5	36.7	46.7	
Manual	5799	1.4	13.3	36.1	48.9	
Household SLI						
Low	19 946	2.1	17.0	40.3	40.5	1512.941,[a] df = 6
Medium	34 911	1.3	12.5	34.8	51.4	
High	17 803	0.8	9.4	30.2	59.5	
BMI						
Undernutrition	23 295	2.2	16.2	37.3	44.3	705.599,[a] df = 3
Normal	49 365	1.9	11.5	34.2	53.3	

NOTES: df = Degrees of freedom; SC = scheduled caste; ST = scheduled tribe; OBC = other backward castes; SLI = standard of living index in household.
[a] $P < .01$.

prevalence of anemia (54.1%). Also, women in Assam have the lowest mean Hb level (10.49 g/dL), but the highest prevalence of anemia is observed in Orissa (59.8%), followed by West Bengal (58.5%) and Assam (57.5%). Northeastern states such as Manipur, Nagaland, and Sikkim; Goa; and developed states such as New Delhi, Punjab, and Kerala along with

Table 3. Zonewise and Statewise Distribution of Mean Hb and Percentage Distribution of Anemia Among Pregnant Women

	Hb Level		Percentage Distribution of Anemia					
Zones/States	n	Mean	SD	Severe	Moderate	Mild	Any Anemia	Normal
North-Eastern	791	11.02	1.74	1.5	23.5	19.9	44.9	55.1
Arunachal Pradesh	119	11.16	1.45	0.8	14.3	26.9	42.0	58.0
Assam	181	10.49	1.70	2.8	33.1	21.6	57.5	42.5
Manipur	121	11.43	1.62	0.8	16.5	17.4	34.7	65.3
Meghalaya	99	10.59	1.98	2.0	36.4	17.2	55.6	44.4
Mizoram	84	11.10	1.65	1.2	19.0	22.7	42.9	57.1
Nagaland	66	11.94	1.79	0.0	13.6	10.6	24.2	75.8
Sikkim	60	11.31	1.86	3.3	21.7	8.3	33.3	66.7
Tripura	61	10.85	1.47	0.0	24.6	27.9	52.5	47.5
Eastern	987	10.66	1.58	1.5	28.0	24.6	54.1	45.9
Bihar	508	10.77	1.61	2.0	25.6	21.6	49.2	50.8
Orissa	291	10.51	1.56	0.7	32.3	26.8	59.8	40.2
West Bengal	188	10.58	1.52	1.6	27.7	29.2	58.5	41.5
Central	960	10.89	1.78	1.7	27.2	20.9	49.8	50.2
Madhya Pradesh	550	10.83	1.79	0.9	30.0	21.1	52.0	48.0
Uttar Pradesh	410	10.97	1.78	2.7	23.4	20.7	46.8	53.2
Western	606	10.83	1.85	3.3	25.7	19.0	48.0	52.0
Goa	69	11.40	1.58	1.4	10.1	21.8	33.3	66.7
Gujarat	207	10.84	1.91	3.9	28.0	15.0	46.9	53.1
Maharashtra	330	10.71	1.85	3.3	27.6	20.9	51.8	48.2
Northern	1391	11.08	1.75	1.6	22.1	21.2	44.9	55.1
Haryana	171	10.66	1.88	1.8	32.7	20.5	55.0	45.0
Himachal Pradesh	168	11.84	1.52	0.6	10.1	17.3	28.0	72.0
Jammu	164	10.86	1.73	3.7	22.6	18.2	44.5	55.5
New Delhi	134	11.49	1.52	0.7	12.7	20.9	34.3	65.7
Punjab	163	11.33	1.62	0.6	16.0	20.2	36.8	63.2
Rajasthan	591	10.89	1.77	1.7	26.1	23.6	51.4	48.6
Southern	884	11.01	1.66	2.0	21.7	19.9	43.6	56.4
Andhra Pradesh	170	10.96	1.57	2.4	20.6	18.8	41.8	58.2
Karnataka	271	10.87	1.78	3.0	24.4	20.2	47.6	52.4
Kerala	139	11.90	1.31	0.0	8.6	10.8	19.4	80.6
Tamil Nadu	304	10.77	1.61	2.0	26.0	24.0	52.0	48.0
India	5619	10.93	1.73	1.8	24.5	21.2	47.5	52.5

NOTES: Hb = hemoglobin; SD = standard deviation.

Himachal Pradesh (<40%) have lower prevalence of anemia than the other states. In Kerala, only 19.4% women are anemic during pregnancy. Among all the states, the highest prevalence of severe anemia is found in Gujarat (3.9%). Though the overall percentage distributions (statewise and zonewise) of anemia among pregnant women are somewhat less than those for nonpregnant women, the level has been seen to be more for pregnant women. This is evident when we compare the percentage distributions of mild and moderate anemia between pregnant and nonpregnant women.

Table 4. Categorywise Distribution of Different Levels of Anemia Among Pregnant Women in Terms of Economic and Biosocial Factors

Factors	n	Percentage Distribution of Anemia				χ^2 Value
		Severe	Moderate	Mild	Normal	
Age group (years)						
Less than 25	3403	1.7	24.2	21.4	52.6	4.085 (ns), df = 6
25-34	1962	2.0	24.5	20.6	52.9	
35 and above	254	2.0	29.1	20.5	48.4	
Religion						
Hindu	4204	2.0	26.1	21.4	50.6	37.940,[a] df = 9
Muslim	762	1.8	19.4	21.5	57.2	
Christian	379	0.8	20.6	16.4	62.3	
Others	274	1.5	20.1	22.3	56.2	
Ethnicity						
SC	1.32	2.5	29.6	19.7	48.3	44.352,[a] df = 9
ST	926	1.7	26.3	22.6	49.4	
OBC	1631	1.4	24.5	22.7	51.4	
None of them	2030	1.9	21.2	19.9	57.0	
Residence						
Urban	1447	0.7	20.3	20.1	58.9	43.772,[a] df = 3
Rural	4172	2.2	26.0	21.5	50.3	
Education						
No education	2601	2.5	28.3	21.3	47.9	108.472,[a] df = 9
Primary	955	2.1	26.2	20.1	51.6	
Secondary	1488	1.2	20.9	22.2	55.6	
Higher	575	0.2	13.9	18.8	67.1	
Occupation						
Household work	3824	1.4	24.1	21.3	53.2	41.897,[a] df = 9
Professional/sales/service	204	1.5	16.2	15.7	66.7	
Agriculture	1236	3.1	27.8	20.8	48.4	
Manual	355	2.3	23.1	22.8	51.8	
Household SLI						
Low	1747	3.3	30.2	21.2	45.3	106.786,[a] df = 6
Medium	2841	1.3	23.0	22.0	53.6	
High	1031	0.8	19.1	18.3	61.8	
BMI						
Undernutrition	1117	2.3	23.3	20.9	53.4	2.982 (ns), df = 3
Normal	4502	1.7	24.8	21.1	52.3	

NOTES: ns = Not significant; df = degrees of freedom; SC = scheduled caste; ST = scheduled tribe; OBC = other backward castes; SLI = standard of living index in household.
[a] $P < .01$.

The percentage distribution of anemia among pregnant women as a function of economic and biosocial factors (Table 4) also reveals results similar to that for nonpregnant women. Hindu, rural, illiterate women and women with low household SLI suffer more from anemia than others. Here also we see a shift of percentages of anemic women from mild to moderate when we go from nonpregnant women to pregnant women. Interestingly,

Table 5. Results of Binary Logistic Regression of Anemia on the Different Economic and Biosocial Factors Among Nonpregnant Women (Anemic, ie, Hb < 12.0 g/dL as a Dependent Variable)

Variable	*B*	Significance	Exp (*B*)
Age group (years)			
Less than 25	0.21	0.00	1.24
25-34	0.05	0.06	1.05
35-44	0.05	0.07	1.05
45 and above (R)	—	—	—
Religion			
Hindu	0.15	0.00	1.16
Muslim	0.07	0.08	1.08
Christian	–0.36	0.00	0.69
Others (R)	—	—	—
Ethnicity			
SC	0.10	0.00	1.11
ST	0.42	0.00	1.53
OBC	0.04	0.03	1.04
None of them (R)	—	—	—
Residence			
Urban	–0.00	0.64	0.99
Rural (R)	—	—	—
Education			
No education	0.30	0.00	1.36
Primary	0.23	0.00	1.26
Secondary	0.11	0.00	1.12
Higher (R)	—	—	—
Occupation			
Household work	0.08	0.01	1.8
Prof./sales/service	–0.03	0.44	0.97
Agriculture	–0.00	0.93	0.99
Manual (R)	—	—	—
Household SLI			
Low	0.47	0.00	1.60
Medium	0.15	0.00	1.16
High (R)	—	—	—
BMI			
Undernutrition	0.19	0.00	1.22
Normal (R)	—	—	—
Constant	–0.80	0.00	

NOTES: SC = scheduled caste; ST = scheduled tribe; OBC = other backward castes; SLI = standard of living index in household; (R) = reference group.

undernourished women (BMI < 18.5 kg/m^2) have a slightly lower prevalence of anemia (46.6%) compared with their normal counterparts (47.7%). However, this is not statistically significant.

Binary logistic regressions have been carried out separately for pregnant and nonpregnant women to see whether age group, religion, ethnicity, place of residence, level of

Table 6. Results of Binary Logistic Regression of Anemia on the Different Economic and Biosocial Factors Among Pregnant Women (Anemic, ie, Hb < 11.0 g/dL as a Dependent Variable)

Variable	*B*	Significance	Exp (*B*)
Age group (years)			
Less than 25	–0.14	0.28	0.88
25-34	–0.09	0.50	0.91
35 and above (R)	—	—	—
Religion			
Hindu	0.19	0.14	1.21
Muslim	–0.02	0.90	0.98
Christian	–0.35	0.04	0.70
Others (R)	—	—	—
Ethnicity			
SC	0.14	0.08	1.16
ST	0.25	0.01	1.28
OBC	0.09	0.20	1.09
None of them (R)	—	—	—
Residence			
Urban	–0.10	0.14	0.90
Rural (R)	—	—	—
Education			
No education	0.44	0.00	1.55
Primary	0.41	0.00	1.51
Secondary	0.33	0.00	1.39
Higher (R)	—	—	—
Occupation			
Household work	0.09	0.45	1.09
Professional/sales/service	–0.27	0.17	0.77
Agriculture	0.06	0.62	1.06
Manual (R)	—	—	—
Household SLI			
Low	0.39	0.00	1.49
Medium	0.15	0.07	1.17
High (R)	—	—	—
BMI			
Undernutrition	–0.16	0.02	0.86
Normal (R)	—	—	—
Constant	–0.76	0.00	

NOTES: SC = scheduled caste; ST = scheduled tribe; OBC = other backward castes; SLI = standard of living index in household; (R) = reference group.

education, occupation categories, household SLI, and BMI have any effect on the prevalence of anemia (Tables 5 and 6).

The number of women in the category of age "45 and above" was very low. Therefore, we merged this category with the previous category to get a combined category of age as "35 and above."

Because the binary variable takes a value of 1 for anemic women, a positive value of the coefficient indicates a higher probability of being anemic compared to the reference group.

Table 5 clearly indicates that young women in the age group less than 25 years are significantly more likely to suffer from anemia (Exp (*B*) = 1.24) than older women, especially women aged 45 and above. But for pregnant women, it was just the opposite, though not statistically significant. This is because young pregnant women are usually given more attention than older pregnant women. Hindu women are more likely to be anemic (Exp (*B*) = 1.16) compared with Muslim and Christian women and women from other religious groups. In terms of ethnicity, scheduled castes (SCs), STs, and other backward castes (OBCs) are more likely to be anemic than other caste groups. STs are the most affected.

Almost same picture emerges for pregnant women also. There is no significant difference in the effect of rural and urban places for both pregnant and nonpregnant women. Less educated women or women from low SLI households have a distinctly higher probability of being anemic compared with women with a higher level of education or those from high SLI households, irrespective of whether the women are pregnant or not. So is the case with undernourished women compared with normal women in terms of BMI values. Women's occupation does not play any significant role except for nonpregnant women who are engaged in household work. On the other hand, Christian women, compared with Hindus, Muslims, and other religious groups, are seen to be least anemic. The most interesting finding is that there is no rural–urban difference of probability of being anemic. The rural–urban differences seen in Table 2 are manifested through the other variables taken in the regression.

Discussion

The present study demonstrates low mean values of Hb and high prevalence of anemia at the national level in both nonpregnant and pregnant Indian women. Another national level study considering rural Indian pregnant women in 7 states reported a much higher prevalence of anemia (84.0%) than our study.[27] In Bangladesh, the prevalence of anemia was found to be lower than what is found in our study for both nonpregnant (46.0%) and pregnant (39.0%) women.[28] Chandyo et al[29] found the prevalence of anemia among nonpregnant women in Nepal to be only 12.0%, which is much lower even when compared with the best-performing states in India like Kerala. Although the prevalence of anemia among Sri Lankan nonpregnant women in the year 1973 (68.0%) and pregnant women in the year 1988-1989 (60.0%) was higher than that for Indian women, in 2001, the prevalence was vastly lower for both nonpregnant and pregnant women, at 32.0% and 30.0%, respectively.[30]

Apart from the high prevalence of anemia at the national level, the degree of prevalence varies over different geographical zones and states within India. Nonpregnant and pregnant women from eastern, north eastern, and central zones suffer more from anemia compared with other zones. One should find out why women from northern India suffer more from anemia than their southern counterparts. Such disparities have been noticed among states also. Assam, Meghalaya, and Tripura from the northeastern zone; Bihar, Orissa, and West Bengal from the eastern zone have a much higher prevalence of anemia than the national level. In contrast, except for Tamil Nadu, both nonpregnant and pregnant women from southern zones like Andhra Pradesh, Karnataka, and specifically Kerala have lower prevalence of anemia than the national level. More important, though the prevalence of anemia decreases slightly in pregnant women compared with nonpregnant women, the severity increases among pregnant women, which is evident from the percentages of mildly and moderately anemic women. Similar results were also observed in Bangladeshi women, especially among nonpregnant women.[31]

In the present study, we tried to determine the distribution of anemic women according to the severity of anemia and its association with some economic and biosocial factors. The

prevalence of anemia is higher in lower age groups compared with higher age groups among nonpregnant women. Similar results were observed among Tarahumara nonpregnant women in Northern Mexico.[32] Hindu women are the most vulnerable group both among nonpregnant and pregnant Indian women, whereas Christian women are in the most advantageous position. Ethnic groups, that is, STs and SCs, are also very much affected. Women in poor socioeconomic conditions such as rural women and women with low household SLI are more likely to suffer from anemia. Similar scenarios have also been observed among women from Mexico.[33] Education also plays a major role in determining the nutritional consumption and health behavior among humans, which is reflected in the prevalence of anemia. Women who are engaged in agricultural work are the most affected group for both nonpregnant and pregnant groups. This could be because agricultural lands are more likely to be infested with hookworms and other kinds of worms and parasites. It is difficult to determine the causes for these findings without further investigation. An in-depth study should take food habits and hygiene practices into consideration. The micronutrient deficiencies are also reflected by another morphological variable in the form of BMI. Undernourished women have a comparatively higher prevalence of anemia than normal women. Similar findings have also been reported among nonpregnant women from Andhra Pradesh.[34] These uneven distributions of the prevalence of anemia as a result of some factors are also confirmed through binary logistic regression. Hindu women; STs and SCs; and those who reside in rural areas, are illiterate, engaged in agricultural work, have low household SLI, and are undernourished are more likely to be anemic.

Conclusions

Anemia is one of the major health problems of women in India. It is more severe during pregnancy. This study helps us understand the association between the level of anemia and the biosocial factors. It is seen that the educational level of women and the standard of living of households play a considerable role in determining the degree of anemia in women. Efforts must be made to enhance the level of education and the economic status of all women. There are also considerable regional variations. Thus, our study could help in the choice of the target group and the most important biosocial determinants for combating the problem of anemia.

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