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Prevalence of anaemia in pregnant & lactating women in India

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***Background & objectives*: The prevalence of anaemia during pregnancy and lactation was significantly lower in the National Family Health Survey 1998-1999 (NFHS-2), using the hemocue method for haemoglobin estimation compared to earlier surveys. The present study selected seven States and used the same districts and villages studied in the NFHS-2, to see if the reported reduction in prevalence of anaemia was due to health and nutrition inputs and/or due to a different method for haemoglobin estimation.**

***Methods*: A total of 1751 women (1148 pregnant and 603 lactating- exclusively breastfeeding up to 3 months of age), from seven States- Himachal Pradesh and Haryana in north; Assam and Orissa in east; Kerala and Tamil Nadu in south and Madhya Pradesh in central India, were selected. Haemoglobin was estimated by the cyanmethaemoglobin method, so that comparison was possible with earlier studies. Data on socio-demographic characteristics, pregnancy, nutritional status and dietary intakes were collected.**

***Results*: Prevalence as well as severity of anaemia was significantly higher in the present study as compared to the NFHS-2 study data. The difference could be due to haemocue method, which gives higher haemoglobin values. The contributing factors found on multiple regression analysis for anaemia in pregnancy and lactation were: literacy, occupation and standard living index of the study women; their awareness about anaemia, its prevention by regular consumption of iron-folate tablets and increase in food intake. Maternal height, age of marriage, parity and foetal loss also contributed to haemoglobin level. There were interstate differences; lower fertility, higher literacy and better diet was observed in Himachal Pradesh as compared to Haryana. The literacy and nutritional status of women in Tamil Nadu was lower than Kerala. The remaining 3 states had poor fertility, lower social living index and nutritional status with >90 per cent women being anaemic in pregnancy and lactation. Low prevalence of severe anaemia in Orissa as compared to Assam was due to availability and consumption of iron folate tablets. The antenatal services in the first trimester and checkup by a doctor, along with availability and consumption of iron folate tablets over 3 months in all the States influenced haemoglobin levels.**

***Interpretation & conclusion*: Despite the measures taken to control anaemia in pregnancy and lactation in the last two decades, the severity of nutritional anaemia continues to remain a public health issue of great magnitude, suggesting that these measures have been largely ineffective. The present findings also showed interstate differences particularly in fertility, women education, nutrition status and occupation; availability of antenatal services and iron folate tablets as possible factors responsible for differences in prevalence of anaemia.**

Key words Anaemia - haemoglobin - interstate differences - lactation - pregnancy - rural

Anaemia is the late manifestation of deficiency of nutrient(s) needed for haemoglobin synthesis. Most of the anaemias are due to inadequate supply of nutrients like iron, folic acid and vitamin $B_{12,}$ proteins, amino acids, vitamins A, C, and other vitamins of B-complex group *i.e.*, niacin and pantothenic acid are also involved in the maintenance of haemoglobin level[1].

In India, anaemia affects an estimated 50 per cent of the population[2]. In women, anaemia may become the underlying cause of maternal mortality and perinatal mortality[3]. Anaemia also results in an increased risk of premature delivery and low birth weights. Iron deficiency in late pregnancy results in poor foetal iron stores[4,5]. Latent iron deficiency is known to alter brain iron content and neurotransmitters irreversibly in foetal life and postnatal babies[6,7].

In a study of the Indian Council of Medical Research (ICMR) in 1989[8], prevalence of anaemia in 4181 pregnant rural women of 11 States was estimated and it was demonstrated that 87.6 per cent women had haemoglobin (Hb) <10.9 g/dl. Further, ICMR in 1992[9] reported that in 6 States supplementation of iron-folate tablets to control anaemia (women with haemoglobin < 7.0 g/dl were excluded) had 62 per cent women as responders (anaemic-those responding to haematinic therapy by showing rise in haemoglobin). Even after consuming 90 tablets, 37.8 per cent women had haemoglobin less than 10.0 g/dl and 19.4 per cent had less than 9.0 g/dl. During 1986-1991 haemoglobin estimations in rural pregnant women in Varanasi showed 94.5, 95.3 and 95.9 per cent prevalence of anaemia in I, II and III trimesters[10]. ICMR district nutrition survey 1999-2000 also reported prevalence of anaemia as 84.2 per cent with 13.1 per cent with severe anaemia in pregnancy[11]. Haemoglobin in all these studies was estimated by cyanmethaemoglobin method[12]. Contrary to the above studies, the NFHS-2 (National Family Health Survey, 1998-1999) data[13] using hemocue system reported prevalence of anaemia as 49.7 per cent in pregnant women; 56.4 per cent in breastfeeding non pregnant; and 50.4 per cent among non pregnant non breastfeeding women. Hemocue system estimates higher levels of haemoglobin[14-16], thus is difficult to compare with the earlier studies[8-11]. The Hemocue method is costlier, but operationally easier, more portable and requires less training; hence it can be optimally used in the field work.

It became necessary to assess whether the lower prevalence reported in NFHS-2[13] was due to the improvement in haemoglobin levels following improved antenatal coverage, nutrition support, *etc.*, or due to difference in the method used for estimation of haemoglobin. Further, the interstate differences in prevalence and severity of anaemia in NFHS-2[13] were striking and needed investigations.

The present study was therefore planned to estimate haemoglobin levels in pregnant and lactating women from seven States earlier covered in the NFHS-2[13], using the cyanmethaemoglobin method[12], and to estimate anaemia prevalence in these women to observe the changing trend; and to study the likely aetiological factors influencing the haemoglobin level such as maternal age of marriage, fertility, literacy, occupation, standard living index, nutritional status, dietary intakes, antenatal care, and awareness about anaemia and supplementation of iron folate tablets; and to identify the factors responsible for interstate differences in prevalence and severity of anaemia observed in the study data (NFHS-2 data)[13].

Material & Methods

Sample size: The seven States investigated in the study were Himachal Pradesh (HP) and Haryana in the north; Tamil Nadu (TN) and Kerala in the south; Assam and Orissa in the east and Madhya Pradesh (MP) in central India. The participating centres were (*i*) Assam Agricultural University, Jorhat, Assam; (*ii*) Haryana Agricultural University, Hissar, Haryana; (*iii*) Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh; (*iv*) Medical College

Thriventhipuram, Kerala; (*v*) RIGHTS consultants, Gwalior, Madhya Pradesh; (*vi*) Orissa Institute of Medical Research and Health, Cuttuck, Orissa; and (*vii*) Avinashilingam University, Coimbatore, Tamil Nadu.

The study was carried out from September 2001 to April 2003. In the respective States, the monsoon season was avoided as the villages were not accessible due to heavy rains.

The number of districts, villages and the target women selected from each of the seven States are given in Table I. The sample of households and villages for the present study in each State was drawn as a sub-sample of households and villages investigated in the NFHS-2 sample[13]. The sample selection was done in two stages. The selected villages were stratified into tertiles on the basis of prevalence of anaemia as per NFHS-2. A total of 20 villages were selected from the different tertiles, the number of villages being proportional to the tertile/size. From each of the 20 villages, all households with pregnant and lactating women (up to 3 months of exclusive breast feeding) were identified. Using a simple random sample technique 15 pregnant and lactating women were selected. In case the selected village did not have 15 women, the neighbouring village was taken out of the selected reserve list. However, number of villages was limited to 30 (Table I).

Table I. Total number of districts, villages and target women (n) studied

State	District	Villages	Target women (pregnant + lactating)
Assam	13	20	(132+93) 225
Haryana	9	20	(188+112) 300
Himachal Pradesh	9	30	(94+76) 170
Kerala	11	20	(244+56) 300
Madhya Pradesh	16	24	(125+44) 169
Orissa	7	23	(164+134) 298
Tamil Nadu	13	20	(201+88) 289
Total			(1148+603) 1751

The following information was collected on a pre-tested proforma:

Socio-demographic particulars of a household: Age at marriage, literacy status and occupation of woman and her husband.

Reproductive behaviour: Age, sex, number of live children and inter-pregnancy interval were recorded. Any pregnancy loss with birth order and gestational age was noted (foetal loss). Current pregnancy details were also recorded.

Antenatal care (ANC): ANC availability, frequency of check ups if conducted in first trimester and if provided by the medical doctor, were recorded.

Nutrition and health education (NE): Availability of facility of imparting NE (with special reference to anaemia of pregnancy) in the respondent's area was assessed.

Availability of supplements: Availability of iron folic acid (IFA) tablets.

Behaviour regarding food consumption: Information on increased food consumption, frequency of smoking and consumption of alcohol was collected.

Dietary intake: The trained field workers calculated the amount of intake of each nutrient by the woman as per cent RDA (recommended dietary allowances) as well as amount using the 'Nutritive value tables[17].

Height and weight of the subjects were measured using anthropometric rod and platform weighing scale, which were standardized repeatedly.

Haemoglobin (Hb) estimation was done by cyanmethaemoglobin method[12], using the filter paper technique. Finger tip was cleaned with spirit, dried and clean puncture made with a sterilized disposable lancet. First drop of the free flowing blood was wiped off and second and if needed third drop was used for haemoglobin estimation. In this, an accurate volume

(20 µl) of blood is drawn into the Hb pipette and immediately delivered on to dry Whatman No.1 filter paper (cut into 1.5 x 1.5 cm squares, and kept dry in an envelope). It is allowed to dry and the squares of paper are labeled. These squares are then dropped into 5 ml of Drabkin's solution (within 48-72 h), and the blood is allowed to diffuse out of the filter paper into the diluent. The solution is then centrifuged. The supernatant was separated and its absorbance was read at 540 nm in a photoelectric colorimeter (AIMIL Model no.014, - same in all centres). Altitude correction for haemoglobin was applied for the values obtained in Himachal Pradesh[18]. The variation in haemoglobin level on two consecutive determinations (separate finger prick samples) by two field workers was ≤2.8 per cent. The intra-individual variation was ≤1.59 per cent. Every fifth sample was checked by the field worker at the center and every 10th sample was sent to the NIN, Hyderabad for Hb estimation, in the same week. The variation of ±<0.5 g/dl in haemoglobin estimation between the centres and the NIN, Hyderabad was considered acceptable.

Calculation of standard of living index (SLI; modified from NFHS-2)[13]: The standard of living index was calculated taking into consideration certain items. These items were scored in ascending order and scores were calculated for family of each participating woman. From the total scores of each State, the upper, middle and lower quartiles were calculated and the family was accordingly placed in the upper, middle and lower SLI.

Items of household included in the calculation of SLI are given below and SLI was calculated by adding the following scores: *(i)* Type of house: kutcha -1, semi-pucca -2, pucca -3; *(ii)* Source of drinking water: stream/canal/river-1, open well and pond/tank -2, tap and tube well -3; (*iii*) Garbage/waste water disposal: compost pit-3, away from house-2, indiscriminate-1; (*iv*) Type of latrine: open field defecation -1, manually cleaned -2, sanitary latrine -3; (*v*) Source of lighting : no -1, yes -2; (*vi*) Separate kitchen : no - 1, yes - 2; (*vii*) Main fuel for cooking : fire wood -1, kerosene - 2, LPG, biogas and electricity -3; (*viii*) Access to media: Television - no-1, yes-2. radio/transistor - no-1, yes-2. newspaper - no-1, yes-2.

Index scores ranged from 1-26 in each State. As the range was different in all States, individual scores were given for each State which ranged from low, medium and high SLI.

The data for intestinal parasites or malaria in the subjects could not be obtained as collection of stool samples was very difficult. However, no subject had clinical features of malaria at the time of blood collection.

Standardization and training of investigators: To ensure uniform and consistent methodology for haemoglobin estimation, anthropometry and for the interviews to be followed in all centres for data collection, the selected field workers (three in each) of seven states were trained at the National Institute of Nutrition, Hyderabad during June 25-29, 2001. The field training was for haemoglobin estimation (one field worker was trained, exclusively); anthropometric assessment; enumeration of target women in the villages; use of random number tables to select the study women; dietary survey and to record history of early reproductive life, utilization of health services, education related to health and nutrition, *etc*.

These centres were provided standardized tools: (*i*) anthropometeric rod; (*ii*) Drabkin's solution (cyanmethaemoglobin solution for haemoglobin estimation); (*iii*) haemoglobin standard; (*iv*) deonised water; (*v*) Whatmann filter paper; (*vi*) haemoglobin pipettes; and (*vii*) weighing measurement sets for dietary survey. These were checked and standardized at NIN, Hyderabad. The field workers were made to practice during the training period. The blood collectors were trained carefully and taught not to "milk" the finger for blood collection. For weighing scales and colorimeters specifications were given to procure locally. The colorimeter and cuvettes were similar, weighting scale standardized repeatedly, thus unlikely to affect measurements.

One of the investigator (KNA) who had participated in training at NIN, Hyderabad, visited all the states (except HP) to reorient the investigators, develop uniform data sheets and standardize haemoglobin estimation.

Analysis of data: Data were analyzed for pregnant and lactating women separately for likely differences. SPSS package was used for analysis. Parametric tests such as t-tests or ANOVA were used to test significance of differences. In case of access to and utilization of health services, the data were presented in percentages as well as numbers. Multivariate analysis was undertaken to study the influence of the maternal socio-demographic status, age of marriage, fertility, nutritional, awareness about anaemia and contribution of iron folic acid tablet (IFAT) consumption on her haemoglobin level.

For comparison with the NFHS-2[13] haemoglobin data for the studied villages were specially obtained. The consumption of alcohol was observed in some women in Assam, thus no further analysis was done. Smoking was negligible, and was therefore not analyzed.

Results

Prevalence and severity of anaemia: A total of 84 per cent pregnant and 92.2 per cent lactating women were anaemic with severe anaemia in 9.2 and 7.3 per cent respectively; 39.2 and 27.3 per cent in Madhya Pradesh, 14.4 and 8.6 per cent in Assam and 8.5 and 13.4 per cent in Haryana had severe anaemia in pregnancy and lactation, respectively (Tables II & III). In the present study prevalence as well as severity (moderate to severe) of anaemia was more as compared to the NFHS 2 study data[13]. In Himachal

Table II. Percentage distribution of pregnant women of the present study in various haemoglobin (Hb) groups as compared to NFHS-2 data[13]

	Haemoglobin groups				% women with
	<7.0 g/dl	7.0-9.9 g/dl	10.0-10.9 g/dl	≥11.0 g/dl	any anaemia
Present study (1148)	9.2 (106)	51.2 (588)	23.5 (270)	16.0 (184)	84.0 (1148)
States:					
Assam (132)	14.4	72.7	6.8	6.1	93.9
NFHS-2 (217)	3.5	34.2	25.6	37.7	62.3
Haryana (188)	8.5	63.3	19.1	9.0	91.0
NFHS-2 (174)	1.8	33.1	20.6	44.5	55.5
Himachal Pradash (94)	0.0	29.8	38.3	31.9	68.1
NFHS-2 (176)	0.7	12.8	18.3	68.2	31.8
Kerala (244)	2.9	21.3	33.6	42.2	57.8
NFHS-2 (140)	0.0	8.7	11.6	79.7	20.3
Madhya Pradesh (125)	39.2	52.8	4.8	3.2	96.8
NFHS-2 (533)	0.9	31.0	21.9	46.2	53.8
Orissa (164)	4.9	68.3	23.8	3.0	97.0
NFHS-2 (297)	0.7	33.0	26.8	39.5	60.5
Tamil Nadu (201)	3.0	57.7	30.8	8.5	91.5
NFHS-2 (310)	4.6	27.1	25.5	42.9	57.1

Number of pregnant women is given in parenthesis

Pradesh severe anaemia was not observed in the present study as compared to 0.7 and 1 per cent in pregnant and lactating women in NFHS study[13]. Around 51 per cent women in pregnancy and lactation had moderate degree of anaemia (Hb 7.0-9.9 g/dl). In Kerala 57.8 per cent pregnant women were anaemic with 2.9 per cent having severe anaemia (Table II). On further analysis severe anaemia in Kerala was limited to village Nedumpana in Kollam district (prevalence 13.3%; with interpregnancy interval of 11 months, data not shown). 1.8 per cent pregnant women in overall sample and 13.3 per cent in MP had haemoglobin <5.0 g/dl, 19.3 per cent had <8.0 g/dl in pregnancy. During lactation no women had haemoglobin < 5.0 g/dl (data not presented).

Socio-demographic characteristics :

Literacy status- The illiteracy (those who neither can read nor write) among women was highest in MP (68.0%) followed by 46.3, 45.3, 30.7, 28.7, 8.8 and 1.3 per cent in the States of Orissa, Assam, Haryana, Tamil Nadu, HP and Kerala, respectively; 37.8 per cent husbands were illiterate followed by State of MP (31.4%), Orissa (28.9%), Tamil Nadu (22.1%), and Haryana (19.3%). Kerala had no illiterate man followed by only 2.4 per cent in HP (Tables IV-VI).

Occupation- In MP only 43.8 per cent women were housewives followed by 61.8 per cent in Himachal Pradesh. In other States more than 80 per cent women were housewives; maximum being in Kerala 94.3 per cent. The working women were engaged in agriculture, road or other employment as labourer.

Age of marriage - The mean age of marriage was 18.3 ± 1.5 yr in Assam; 17.5 ± 2.9 yr in Haryana; 22.0 ± 3.5 in HP; 25.3 ± 4.7 in Kerala; 17.1 ± 2.5 in MP; 19.3 ± 2.5 in Orissa and 19.1 ± 2.9 in Tamil Nadu (Tables IV-VI; F=66.8; *P*<001).

Social living index- The families in low SLI were highest in Orissa 60.4 per cent followed by 24.9 per cent in Assam, 22.5 per cent in MP, 21.0 per cent in

Table III. Percentage distribution of lactating women of the present study in various haemoglobin (Hb) groups (lactating period is limited to 3 months) as compared to NFHS-2 data[13]

	Hb groups				
	<7.0 g/dl	7.0-9.9 g/dl	10.0-11.9 g/dl	>12.0 g/dl	% of women with any anaemia
Present study (603)	7.3 (44)	50.9 (307)	34.0 (205)	7.8 (47)	92.2 (603)
States:					
Assam (93)	8.6	67.7	19.4	4.3	95.7
NFHS-2 (685)	1.0	24.8	45.1	29.1	70.9
Haryana (112)	13.4	57.1	25.0	4.5	95.5
NFHS-2 (649)	2.5	20.3	33.3	44.9	56.1
Himachal Pradash (76)	0.0	30.3	60.5	9.2	90.8
NFHS-2 (524)	1.0	10.0	36.5	52.4	47.6
Kerala (56)	0.0	14.3	46.4	39.3	60.7
NFHS-2 (455)	0.2	1.1	20.0	78.7	21.3
Madhya Pradesh (44)	27.3	54.5	18.2	0	100.0
NFHS-2 (1806)	1.2	14.8	42.0	42	58.0
Orissa (134)	3.7	61.2	34.3	0.7	99.3
NFHS-2 (1098)	1.1	17.9	45.8	35.2	64.8
Tamil Nadu (88)	3.4	50.0	37.5	9.1	90.9
NFHS-2 (607)	3.5	19.3	38.7	38.4	61.6

Kerala, 18.3 per cent in Tamil Nadu and 15.3 per cent in Himachal Pradesh. High SLI group women were 29.3, 26.6, 24.7, 21.0 and 19 per cent in Assam, Madhya Pradesh, Haryana, Kerala and TN respectively. The figures were lower for Orissa 6.4 per cent and HP- 12.9 per cent (Tables IV-VI).

Pregnancy and nutritional status- Himachal Pradesh (HP) with anaemia prevalence of 68.1 and 65.8 per cent in pregnancy and lactation respectively, women had higher mean age of marriage, lower parity (1.5) and foetal loss than Haryana. In contrast, neighboring State of Haryana had lower age of marriage ($P< 0.001$), higher parity of 2.6 ($P< 0.001$), and foetal loss of 0.33. Himachal Pradesh women were taller by >6.0 cm, but had lower weight by 3.0 kg (Table IV; $P<0.002$ & <0.001 respectively). Haryana women consumed significantly higher quantity of fat and had lower intakes of energy and protein (Table IV). In Kerala and Tamil Nadu women with similar pattern for parity, and IPI (inter pregnancy interval) but higher foetal loss showed significant differences in the prevalence of anaemia. Kerala women were taller and heavier than Tamil Nadu women; marriage age was significantly lower ($P<0.01$) in Tamil Nadu women (Table V). Women in TN consumed

Table IV. Maternal characteristics between Haryana and Himachal Pradesh

Maternal characteristics	Haryana (300)	Himachal Pradesh (170)	*P* values[+]
Marriage age (yr)	17.5 ± 2.9	22.0 ± 3.5[*]	< 0.001
Pregnancy number	2.6 ±1.5	1.5 ± 0.8[*]	<0.001
Birth order >3 as %	7.4 (22)	1.8 (2)	
Foetal loss	0.33 ± 0.63	0.05 ± 0.3	
Interpregnancy interval (months)	18.7± 9.9	16.1 ± 8.7	
Education of women> 10th class (%)	67.0 (201)	66.4 (113)	
Education of husband >10th class (%)	79.1 (237)	83.5 (142)	
Aware about anaemia (%)	49.0 (147)	29.0[++] (50)	11.2; <0.05
% given IFAT[*]	68.0 (204)	95.3 (162)	
% received IFAT[*] >3 months	26.5 (54)	86.4[++] (147)	9.4; <0.05
% who consumed all the supply of the IFAT[*]	74.1 (40)	85.7 (126)	
ANC by doctor (%)	12.0 (36)	94.1[++] (160)	8.9; <0.01
ANC in 1st trimester (%)	31.7 (95)	82.9[++] (141)	12.3; <0.05
Nutritional status: (Mean± SD)			
Height (cm)	153.2 ± 4.4	159.8 ± 9.2[+]	<0.002
Weight (kg)	49.5 ± 7.3	46.4 ± 5.6[+]	<0.001
Haemoglobin (g/dl)	9.0 ± 1.6	10.4 ±1.2[+]	<0.01
Nutrient intakes			
Energy (kCal)	1710 ± 587	1949 ± 859[+]	<0.049
Protein (g)	49.3 ± 17.9	66.0 ± 33.4[+]	<0.001
Fat (g)	48.4 ± 17.1	30.0 ± 17.5[+]	<0.001
Iron (mg)	17.6 ± 7.0	29.8 ± 30.0[+]	<0.002
FFA (µg)	159.6 ± 85.9	76.6 ± 68.0[+]	<0.001
Vitamin C (mg)	27 ± 25	51± 42	
Social living index (%) Low	22.0 (73)	15.3 (26)	
High	24.7 (74)	12.9 (22)	

Figure in parenthesis give the sample size
[+]Unpaired 't'- test; [++]Chi squire test; ANC, antenatal care; IFAT, iron folate tablet; FFA, free folic acid
[*]This percentage figure is out of the women who received IFAT

significantly lower amount of protein (P<0.003). The States of Assam, Orissa and MP had anaemia prevalence of > 90 per cent in pregnancy as well as in lactation. These States have lower marriage age, poor fertility indices and lower weight and height as compared to others States (Table VI).

Antenatal care: Over 80 per cent women received antenatal care in first trimester in Himachal Pradesh and Kerala followed by Tamil Nadu (61.9%); 94.1 per cent in Himachal Pradesh, 73.5 per cent in Orissa, 71 per cent in Kerala and 50.2 per cent in Tamil Nadu received antenatal care from a medical doctor. Availability of the doctor in pregnancy was poor in MP, Haryana and Assam. In Assam, 61.8 per cent pregnant women never received any ANC (Tables IV-VI). In Himachal Pradesh and Kerala availability and consumption of iron folate tablets for 3 months or more, in pregnancy was significantly higher, as compared to other States. The consumption of IFAT (iron folic acid tablet) was lowest in Assam and MP. Orissa had lower prevalence of severe anaemia as significantly more women were aware about anaemia and consumed IFAT for 3 months as compared to Assam and MP (Table VI).

Table V. Maternal characteristics between Kerala and Tamil Nadu

Maternal characteristics	Kerala (300)	Tamil Nadu (289)	P values[x]
Marriage age (yr)	25.3 ± 4.7	23.3 ± 4.1[x]	<0.01
Pregnancy number	2.0 ± 1.1	2.0 ± 1.1	
Birth order >3 as %	1.7 (5)	2.0 (6)	
Foetal loss	0.05 ± 0.3	0.3 ± 0.4	
Interpregnancy interval (months)	18.6 ± 13.9	19.3 ± 11.4	
Education of women > 10th class (%)	95.3 (286)	58.9 (170)	
Education of husband >10th class (%)	95.7 (287)	67.5 (195)	
Aware about anaemia (%)	74.3 (223)	15.9 (46)	16.1; <0.01
% given IFAT	91.0 (273)	66.8 (193)	
% received IFAT >3 months	55.8 (152)	43.5 (84)	
% who consumed all the supply of the IFAT[*]	96.7 (147)	71.4 (60)	
ANC by doctor (%)	71.0 (213)	50.2 (145)	
ANC in Ist trimester (%)	81.3 (244)	61.9 (179)	
Nutritional status: (Mean± SD)			
Height (cm)	154.2 ± 5.9	151.4 ± 5.8	
Weight (kg)	53.2 ± 8.8	46.4 ± 6.6[x]	<0.01
Haemoglobin (g/dl)	10.8 ± 1.5	9.6 ± 1.3[x]	<0.01
Nutrient intakes (per day)			
Energy (kCal)	1850 ± 526	2012 ± 514	
Protein (g)	61.0 ± 25.2	44.3 ± 12.8[x]	<0.003
Fat (g)	26.8 ±12.5	23.6 ± 12.9	
Iron (mg)	17.1 ± 11.0	11.3 ± 6.7	
FFA (µg)	64.3 ± 45.3	105.4 ± 58.3	
Vitamin C (mg)	72 ± 62	36 ± 35	
Social living index (%) Low	21.0 (70)	18.3 (53)	
High	21.3 (64)	19.0 (55)	

Figures in parenthesis give the sample size
[*]This percentage figure is out of the women who received IFAT
[x]Unpaired t test; [xx]Chi square test

Dietary intakes: For the current pregnancy, energy and protein intakes were lower than the recommended dietary allowances (RDA) in all the States. This was true for the pregnant as well as lactating women[17]. The intake of important dietary items necessary for haemoglobin synthesis *i.e.*, iron and FFA (free folic acid) were much lower than the RDA in all the States, HP consumed 30 mg iron (82.3% of RDA) and 77 µg FFA (< 20% of RDA) and corresponding figures for Kerala were 17 mg and 64.3 µg, in Table V respectively. TN women consumed only 11 mg iron per day (less than 1/3 rd of the RDA); women in Assam, Haryana, Orissa and MP consumed less than or closer to 50 per cent of the RDA. FFA intakes were much lower than the RDA; Assam women consumed only 45.5 µg with 14 mg iron per day (the lowest values among all the States). Vitamin A intake was lower than the RDA in all the States, except Haryana 890 µg/day (RDA 600 µg/day), the fat consumption was more than the RDA in pregnancy and further increased in lactation. Vitamin C intake was close to the RDA except for Haryana and Assam (Tables IV-VI).

Table VI. Maternal characteristics between Assam, Orissa and Madhya Pradesh

Maternal characteristics	Assam (a) (225)	Orissa (b) (298)	Madhya (c) Pradesh (169)
Marriage age (yr)	18.3 ± 1.5	19.3 ± 2.5	17.1 ± 2.5
Pregnancy number	2.5 ± 1.5	2.4 ±1.6	2.6 ± 1.4
Birth order >3 as %	15.1 (34)	9.7 (29)	7.7 (13)
Foetal loss	0.36 ± 0.71	0.30 ± 0.6	0.10 ± 0.4[x]
Interpregnancy interval months	21.5 ±10.7	19.3 ± 11.3	20.6 ± 10.2
Education of women > 10th class (%)	38.3 (86)	43.6 (130)	24.3 (41)
Education of husband >10th class (%)	46.2 (104)	58.7 (175)	56.8 (96)
Aware about anaemia (%)	4.0 (9)	30.9 (92)	9.5 (16)
% given IFAT	32.0 (72)	58.4 (174)	74.6 (126)
% received IFAT >3 months	12.0 (9)	29.9 (52)	6.3 (8)
% who consumed all the supply of the IFAT•	4.9 (5)	63.5 (33)	6.3 (8)
ANC by doctor (%)	24.4 (55)	73.5 (219)	0.6 (1)
ANC in Ist trimester (%)	17.8 (40)	39.3 (117)	17.8 (30)
No ANC done	61.8 (139)	12.1 (36)	22.5 (38)
Nutritional status: (Mean ± SD)			
Height (cm)	150.3 ± 5.1	148.9 ± 5.4	150.1 ± 4.5
Weight (kg)	44.7 ± 6.2	44.4 ± 5.6	46.9 ± 6.1
Haemoglobin (g/dl)	8.6 ±1.6	9.3 ± 1.2	7.7 ± 2.0*
Nutrient intakes			
Energy (kCal)	1934 ± 447	2009 ± 567	1404 ± 427[x]
Protein (g)	50.0 ± 18.3	46.7 ± 18.3	50.3 ± 15.6
Fat (g)	12.2 ± 6.6	13.4 ± 9.5	26.8 ± 11.9[x]
Iron (mg)	14.1 ± 8.8	15.0 ± 12.2	19.8 ± 9.4
FFA (µg)	45.5 ± 26.5	56.9 ± 36.2	60.0 ± 29.6
Vitamin C (mg)	30 ± 24	39 ±34	50 ± 51
Social living index (%) Low	24.9 (56)	60.4 (180)	22.5 (38)
High	29.3 (66)	6.4 (19)	26.6 (45)

Figures in parenthesis give the sample size
•This percentage figure is out of the women who received IFAT
[x]*P*<0.001 compared to a and b (Tukey's test)

In lactation, RDA for energy during lactation (2425 kcal/day) is higher by 250 Kcal/day than the RDA for pregnancy. Women in all States were consuming energy lower than the RDA during lactation. There was marginal increase in energy intake during pregnancy *i.e.*, HP 269, Haryana 100, Kerala 90, MP (no change), Orissa 59 and TN 45 Kcal/day. Surprisingly, in Assam, the energy intake for lactating women further reduced by 75 Kcal/day and was lower by 535 Kcal/day as compared to the RDA. Protein intake in lactation is 75 g/day (RDA), higher by 10 g than in pregnancy; only HP consumed the desired RDA.

The analysis of variance also showed that intakes for all nutrients was significantly more in higher haemoglobin groups, except for vitamins A and free folic acid.

Multiple regression analysis: Multiple regression analysis taking haemoglobin as dependent variable against maternal characteristics in the current pregnancy, demonstrated that women with more education, height, age of marriage, in higher SLI, with higher consumption of IFAT and energy contributed positively to haemoglobin level. Women working as labourer, having higher parity and foetal loss and those not consuming IFAT regularly or not aware about anaemia negatively affected the haemoglobin. Health and nutrition education, literacy and occupation of the husband and interpregnancy interval did not show any relationship with haemoglobin (Table VII).

Discussion

The present study demonstrated higher prevalence of anaemia both in pregnancy and lactation as compared to the reported levels in NFHS-2[13], in the study States. Inspite of the significantly higher haemoglobin levels and lower prevalence of anaemia reported in NFHS-2 survey[13], the pattern of interstate

Table VII. Multiple regression analysis on socio-demographic characteristics, energy intake, anaemia awareness, consumption of IFAT and pregnancy characteristics taking haemoglobin as dependent variable

	Unstandardized coefficients		Standardized coefficients		
	Beta	Std. Error	B	t	Sig.
(Constant)	3.050	1.029		2.964	0.003
Literacy of women	0.148	0.049	0.098	3.043	0.002
Literacy of husband	0.030	0.048	0.020	0.636	0.525
Occupation of husband	0.031	0.019	0.037	1.619	0.106
Women working as labourer	-0.078	0.032	-0.057	-2.453	0.014
Health & nutrition education	0.020	0.063	0.008	0.309	0.758
Not aware about anaemia	-0.052	0.026	-0.049	-2.036	0.042
Total number of tablets consumed•	0.086	0.034	0.159	2.513	0.012
No regular consumption of tablets•	-0.082	0.033	-0.170	-2.504	0.012
Height (cm)	0.025	0.007	0.093	3.804	<0.001
Pregnancy number	-0.095	0.037	-0.073	-2.555	0.011
Foetal loss	0.166	0.084	0.051	1.972	0.049
Inter pregnancy interval (months)	0.002	0.004	0.015	0.622	0.534
Age at marriage (yr)	0.052	0.013	0.100	3.899	<0.001
Energy (kcal)	0.005	0.002	0.071	3.072	0.002
Social living index	0.058	0.014	0.120	4.199	<0.001

IFAT, Iron folate tablet*

differences was similar to the present study (Tables II & III). The prevalence of anaemia was lowest in Kerala. The ICMR district nutrition survey[11] data reported anaemia prevalence of 84.2 per cent (with severe anaemia 13.1%) closer to the present study rural data. Comparative data (as compared to the present study States) for four States in the National Nutrition Monitoring Bureau (NNMB-2003)[19] and seven States in the District Level Household Survey (DLHS)[20], Ministry of Health & Family Welfare phase-1 2004, using cyanmethaemoglobin method also showed higher prevalence of anaemia as compared to the NFHS-2[13].

ICMR data[11] in the same districts also reported 90.1 per cent adolescent girls with anaemia (7.3% having severe anaemia); these findings suggest continuation of anaemia throughout life in women.

The present study showed 1.8 per cent women with haemoglobin <5.0 g/dl, 19.3 per cent with <8.0 g/dl and 9.2 per cent with < 7 g/dl haemoglobin level, in pregnancy; being similar to the ICMR 1989 (rural data- 1985-86)[8] having 22.7 per cent pregnant women <8 g/dl and 10.4 per cent <7.0 g/dl haemoglobin levels. Thus showing no change in severity of anaemia in last 15 yr.

The present study suggested that (*i*) the cyanmethaemoglobin method using filter paper collection technique was feasible in field studies, (*ii*) there was higher prevalence of anaemia in rural pregnant and lactating women compared to that reported in the NFHS-2[13]; (*iii*) there were interstate differences in prevalence of anaemia and its causative factors; (*iv*) the key to controlling anaemia could be in providing ANC services in the first trimester preferably by a doctor and more consumption of iron-folate tablets in pregnancy and lactation.

To conclude, prevalence of anaemia and severity in rural pregnant and lactating women was much higher than that reflected in NFHS-2[13]; this being mainly due to difference in haemoglobin estimation technique. The interstate differences and achievements of Himachal Pradesh in recent years suggest a need for proper antenatal services, supplementation of iron-folate tablets in pregnancy and lactation, nutrition support to meet the RDA during pregnancy and lactation[10], and fertility control by implementation of existing services especially in Haryana, Assam, Madhya Pradesh and Orissa.

Screening for anaemia, treatment of anaemic women, and availability of food fortification (wheat flour with iron and folic acid), milk sugar and salt with iron to build long term iron stores remains the key to reduce anaemia. Even cooking in cast iron utensils improves iron content in diet[7]. The anaemia control programme needs to be implemented more efficiently in these States. The interstate differences observed may guide the health planner to alter the strategies for control of anaemia in poor performing States.

The limitations of the study were that no intervention was planned, worm infestation in these rural women could not be studied, and in a subsample both methods hemocue and cyanmethaemoglobin should have been applied for haemoglobin estimations.

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