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Time trends in prevalence of anaemia in pregnancy

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***Background & objectives*: The prevalence of anaemia in pregnancy in India is among the highest in the world. In the last two decades, several national surveys have estimated haemoglobin levels in pregnant women. In this study, data from these surveys were analyzed to find out changes, if any, in prevalence of anaemia in pregnancy.**

***Methods*: National and State-level estimates on the prevalence of anaemia were tabulated from the reports of the National Family Health Survey (NFHS) 2, NFHS 3, Fact Sheets of NFHS 4 and District Level Household Survey (DLHS) 2. Unit level data from DLHS 4 and Annual Health Survey Clinical Anthropometric and Biochemical component (AHS CAB) were obtained and State level prevalence of different grades of anaemia was estimated. Time trends in the prevalence of anaemia and different grades of anaemia were assessed from these surveys.**

***Results*: NFHS 2, 3 and 4 reported relatively lower prevalence of anaemia as compared to DLHS and AHS CAB. There was not much change in the prevalence or severity of anaemia between NFHS 2, 3 and 4. There was substantial reduction in the prevalence and severity of anaemia in all States except Uttarakhand between DLHS 2 and 4 and DLHS 2 and AHS CAB.**

***Interpretation & conclusions*: There was a reduction in the prevalence and severity of anaemia in the last 15 years. The two-pronged strategy of increasing iron intake (dietary diversification and use of iron-fortified iodized salt) in all the population and testing, and detecting and treating pregnant women with anaemia will accelerate the pace of reduction in anaemia.**

Key words Anaemia - grades of anaemia - pregnancy - prevalence - time trends

India had the highest prevalence of anaemia in pregnancy and is the home of largest number of anaemic pregnant women in the world[1,2]. Anaemia in pregnancy was recognized as a major public health problem in India leading to high maternal morbidity and mortality, low birth-weight and high infant mortality. Several studies[3-5] have confirmed these findings. Earlier studies had shown that anaemia in pregnancy was mainly due to low dietary intake of iron and folate leading to iron and folic acid deficiencies[6,7]. The National Nutritional Anaemia Prophylaxis Programme (NNAPP) aimed at iron and folic acid supplementation during pregnancy was initiated in 1973 in India[8]. The National Anaemia Control Programme (NACP) has been in operation since 1991 and added the test detect and treat strategy for the management of anaemia in all settings[9]. Tenth Five Year Plan[10] reiterated the importance of universal screening of pregnant women for anaemia

and providing appropriate management depending on the severity of anaemia and time available for treatment. The guidelines in the National Iron Plus Initiative (NIPI)[11] elaborate how the programme is to be implemented. It is essential to find out the impact of these national programmes on prevalence and severity of anaemia.

The National Family Health Survey (NFHS) 2[12] in 1998-99 was the first national survey to provide national and State-specific estimates of the prevalence of anaemia and severity of anaemia in pregnancy. Subsequently, NFHS 3[13] (2005-2006) published national- and State-specific estimates of prevalence of anaemia in pregnancy. NFHS 4[14] (2015-2016) Fact Sheets provide the data on the prevalence of anaemia in the country and all States and Union Territories (UTs). NFHS surveys used HemoCue method for haemoglobin (Hb) estimation. District Level Household Surveys (DLHS) 2[15] and 4[16] and Annual Health Survey Clinical Anthropometric and Biochemical component (AHS CAB)[17] were the other large-scale surveys which provided data on the prevalence of anaemia in pregnancy between 2000 and 2016. DLHS 2 and 4 and AHS CAB have used cyanmethaemoglobin method for Hb estimation. DLHS 2 report provides information on the prevalence of anaemia and severity of anaemia in pregnancy at national, State and district levels. However, DLHS 4 fact sheets provide data only on the prevalence of anaemia and severe anaemia in pregnancy. Even though Hb estimation was done in pregnant women AHS CAB fact sheets or report does not provide district and State-specific data on the prevalence of anaemia in pregnancy. The present study was taken up with the objective of assessing changes in prevalence and severity of anaemia in pregnant women over the last 15 years by analyzing the unit level data from DLHS 4 and AHS CAB and comparing the results with DLHS 2 data.

Material & Methods

NFHS 2, 3 and 4 and DLHS 2 and 4 were national surveys coordinated by the International Institute for Population Sciences (IIPS), Mumbai, and AHS CAB was coordinated by Office of Registrar General of India, New Delhi. All these surveys were cross-sectional and were conducted in a representative sample of households throughout the country. NFHS 2, and 3 were designed to provide State-specific data on fertility, mortality and nutritional status (including Hb status of pregnant women) in all major States of India; NFHS 4 provided district and State level estimates of these parameters. Field survey was done by selected survey agencies. NFHS 2 provided data pertaining to 26 States, NFHS 3 pertaining to 29 States and NFHS 4 for 36 States and UTs.

The NFHS 2, 3 and 4 used the HemoCue method (or its modifications) for the estimation of Hb. NHFS 2, 3 and 4 graded anaemia according to the WHO grading of anaemia[18]; pregnant women with Hb levels ≥11 g/dl were graded as non-anaemic; those with Hb levels between 10.0 and 10.9 g/dl as mildly anaemic, those with Hb levels between 7.0 and 9.9 as moderately anaemic and those with Hb levels below 7.0 g/dl as severely anaemic[18]. The prevalence of anaemia and different grades of anaemia at the national and State level were tabulated from the NFHS 2 and 3 national reports and State reports. The prevalence of anaemia at national level and in major States was tabulated from NFHS 4 fact Sheets.

DLHS 2, 4 and AHS (including AHS CAB) were designed to provide district-specific estimates of fertility, mortality and health and nutrition parameters. DLHS 2 was carried out in 35 States and UTs of India in 2002-2004. AHS and AHS-CAB were carried out in Assam (AS), Bihar (BH), Chhattisgarh (CHH), Jharkhand (JH), Madhya Pradesh (MP), Odisha (OD), Rajasthan (RJ), Uttar Pradesh (UP) and Uttarakhand (UK) in 2014. DLHS 4 was done in 2012-13 in 21 States and UTs - Arunachal Pradesh, Andhra Pradesh (AP), Andaman and Nicobar Islands, Chandigarh, Goa, Haryana (HR), Himachal Pradesh (HP), Karnataka (KA), Kerala (KL), Maharashtra (MH), Manipur, Meghalaya, Mizoram, Nagaland, Punjab (PB), Puducherry, Sikkim, Tamil Nadu (TN), Telangana (TG), Tripura and West Bengal (WB). DLHS 4 was not conducted in Delhi (DL) Gujarat (GJ) and Jammu and Kashmir (J&K).

DLHS 2 and 4 and AHS CAB estimated Hb using the classical cyanmethaemoglobin method. DLHS 2 used the grading of anaemia based on Indian data on functional decompensation associated with fall in Hb levels[19-21]. Pregnant women with Hb ≥11 g/dl were graded as not anaemic; those with Hb levels between 8.0 and 10.9 g/dl as mildly anaemic, those with Hb levels between 5.0 and 7.9 g/dl as moderately anaemic and those with Hb levels below 5.0 g/dl as severely anaemic. Data on the prevalence of anaemia and different grades of anaemia at State and national level were tabulated from the report of DLHS 2.

Unit level data after deletion of identifiers were obtained from International Institute for Population

Sciences (IIPS) for DLHS 2 and DLHS 4 and from Ministry of Health & Family Welfare (MoHFW) for AHS CAB. The raw data of NFHS 2 and 3 were obtained from Demographic and Health Survey (DHS) Programme. State-level estimates of the prevalence of anaemia and different grades of anaemia as per the grading used in DLHS 2 were computed in both DLHS 4 and AHS CAB data sets using SPSS software (IBM SPSS Statistics version 16.0, NY, USA). The results were compared with the State level estimates from DLHS 2.

Results

Data on number of pregnant women surveyed from whom blood was collected and for whom valid Hb levels were recorded in the surveys are given in Table I.

Data from NFHS 2 showed that the prevalence of anaemia in pregnant women was 49.7 per cent and that there was no difference in the prevalence of anaemia between non-pregnant and pregnant women (Fig. 1). These findings were initially interpreted as steep fall in the prevalence of anaemia in pregnancy due to successful implementation of NACP. At national level, NFHS3[13] reported a 10 per cent increase in the prevalence of anaemia from NFHS 2 (49.7 to 58.3%). Between NFHS 3 and 4, there was a reduction in the prevalence of anaemia from 58.3 to 50.3 per cent. The prevalence of anaemia in NFHS 4 was comparable to the prevalence of anaemia in NFHS 2 suggesting that there had not been any decline in the prevalence of anaemia in pregnancy over the last two decades (Fig. 1).

Data on the prevalence of anaemia between NFHS 2, 3 and 4 in all major States are given in Fig. 2A and B. Reported prevalence of anaemia in pregnancy in most of the States was relatively low in NFHS 2, 3 and 4. The prevalence of anaemia was higher in Assam, Odisha and Jharkhand as compared to Kerala, Punjab, Himachal and Delhi. No substantial or consistent decline was observed in prevalence of anaemia in pregnant women between NFHS 2, 3 and 4 in any of the States.

Data on changes in different grades of anaemia between NFHS 2 and 3 are shown in Fig. 3A and B. The prevalence of severe anaemia was below 5 per cent in all the States both in NFHS 2 and 3. The prevalence of mild anaemia was relatively low as compared to moderate anaemia in NFHS 2 and 3. This might be attributable to the fact that the range of Hb for mild anaemia was low - only 1 g/dl - while that for moderate anaemia was 3 g/dl. Differences in the prevalence of anaemia between States were of a greater magnitude than the differences between NFHS 2 and 3 in the same State.

Comparison of data on different grades of anaemia in NHFS 2 and 3 showed that there was no substantial decline in the prevalence of different grades of anaemia between the two surveys in any of the States; in many States, there was a small rise in the prevalence of moderate anaemia. As data on prevalence of varying grades of anaemia were not available in the NFHS 4 Fact Sheets, comparison between NFHS 2, 3 and 4 could not be made.

The prevalence of anaemia and different grades of anaemia in pregnant women at the national level in NFHS 2, 3 and DLHS 2 are given in Fig. 4. Data from DLHS 2 showed that the prevalence of anaemia in pregnancy was much higher as compared to NFHS 2 and 3 (Fig. 4). There were differences in the prevalence of mild, moderate and severe anaemia

Table I. Haemoglobin estimation in pregnant women in different national surveys

Survey	No. of women surveyed	Blood samples collected	Valid Hb values
NFHS 2	2796	2501	2003
NFHS 3	3788	3591	3589
DLHS 2	38,710	22,219	19,584
DLHS 4	12,306	11,744	10,606
AHS CAB	20,832	15,836	15,834

NFHS, National Family Health Survey; DLHS, District Level Household Survey; AHS CAB, Annual Health Survey Clinical Anthropometric and Biochemical Component; Hb, Haemoglobin.
Source: Refs 12, 13, 15-17

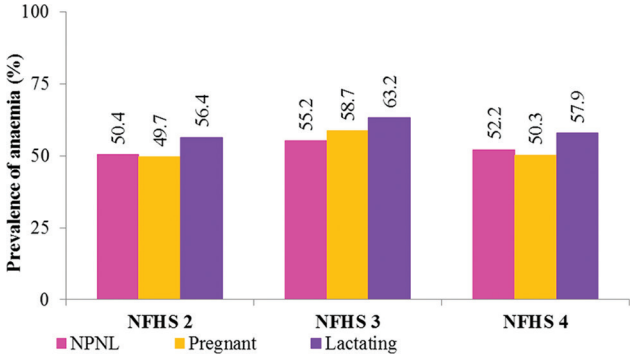

Fig. 1. Per cent prevalence of anaemia in National Family Health Survey (NFHS) 2, 3 and 4. NPNL, non pregnant non lactating.
Source: Refs 12-14.

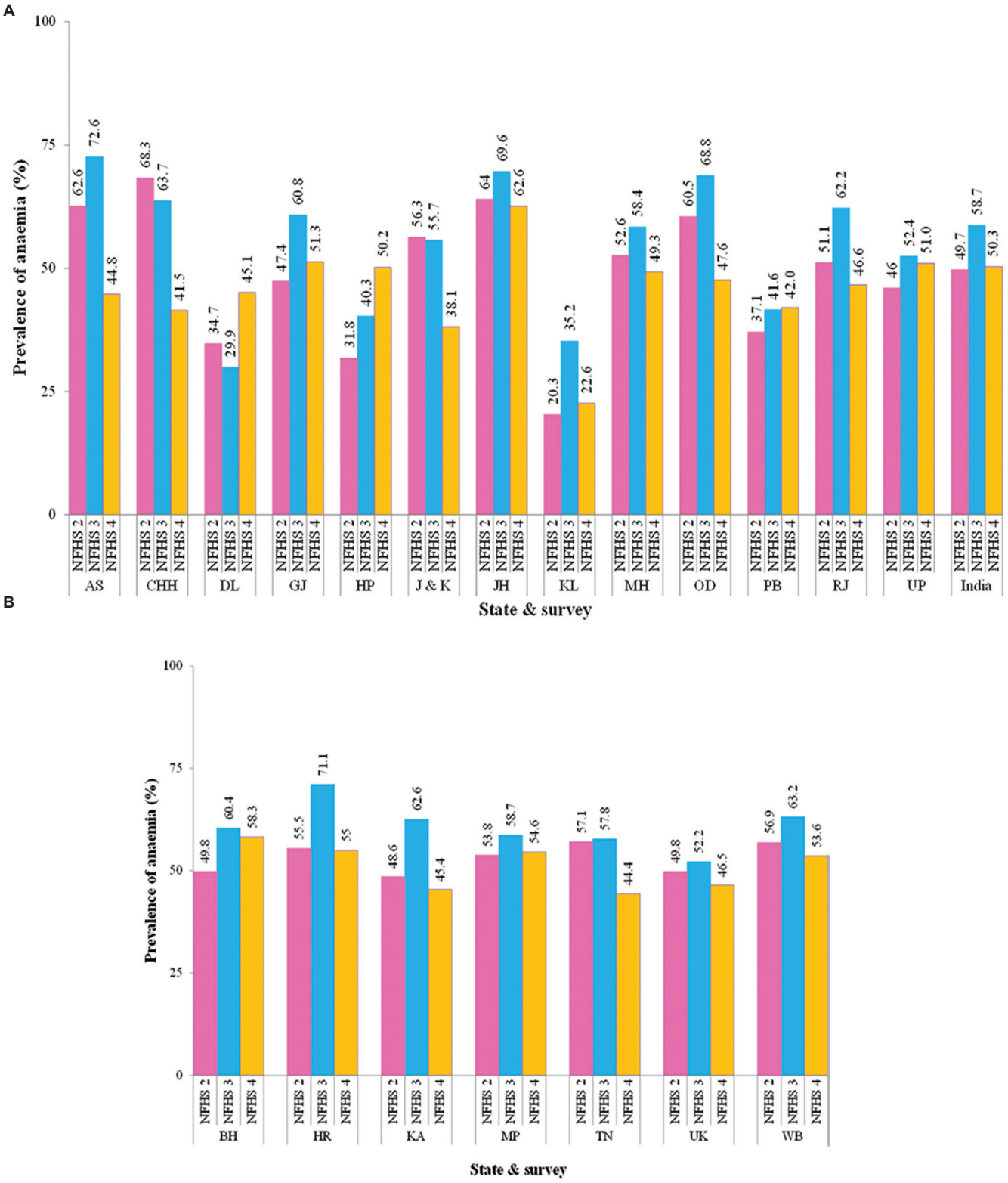

Fig. 2. (A & B) Per cent prevalence of anaemia - National Family Health Survey (NFHS) 2, 3 and 4.
AS, Assam; BH, Bihar; CHH, Chhattisgarh; JH, Jharkhand; MP, Madhya Pradesh; OD, Odisha; RJ, Rajasthan; UP, Uttar Pradesh; UK, Uttarakhand; DL, Delhi; GJ, Gujarat; HR, Haryana; HP, Himachal Pradesh; J&K, Jammu & Kashmir; KA, Karnataka; KL, Kerala; MH, Maharashtra; PB, Punjab; TN, Tamil Nadu; WB, West Bengal.
Source: Refs 12-14.

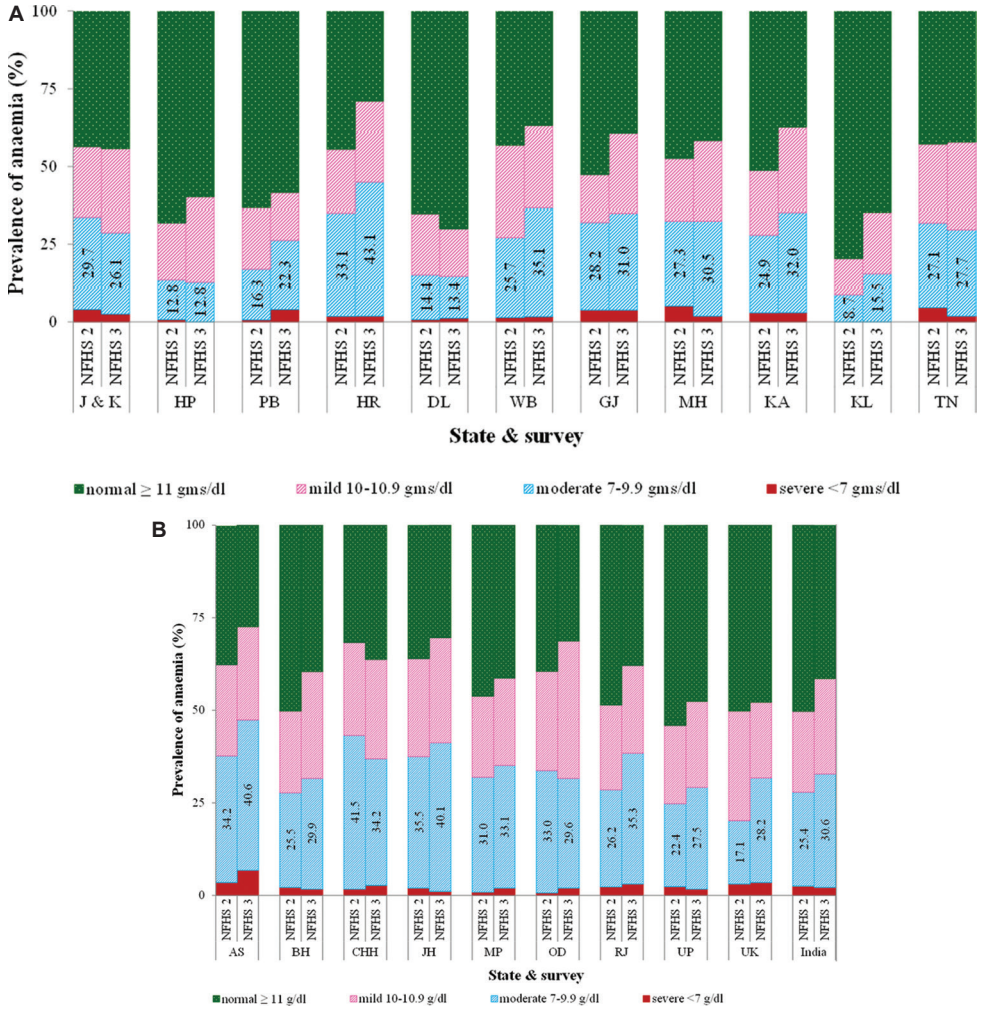

Fig. 3. (A & B) Per cent prevalence of different grades of anaemia (National Family Health Survey 2 and 3). Abbreviations as given in Fig 2. *Source*: Refs 12, 13.

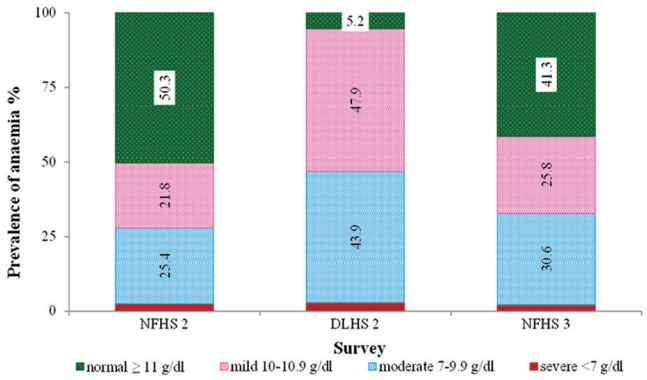

Fig. 4. Prevalence of anaemia at national level in National Family Health Survey (NFHS) 2, 3 and District Level Household Survey (DLHS) 2. *Cut-offs for grading anaemia was different in DLHS 2. *Source*: Refs 12, 13, 15.

between NFHS and DLHS. These differences might partly be attributable to the differences in method used for Hb estimation and partly to the differences in cut-off used for mild, moderate and severe anaemia.

Inter-state comparisons on the prevalence of anaemia between DLHS 2 and DLHS 4 and AHS CAB carried out a decade later showed that in all States except Uttarakhand (where survey in some hilly districts was not carried out in AHS CAB), there was significant decline in the prevalence of anaemia (Figs. 5 & 6). The prevalence of anaemia was lower in the DLHS 4 States as compared to the AHS CAB States. The highest decline in anaemia (nearly 60%) was reported in Kerala and Himachal Pradesh; among the poorly performing states, Chhattisgarh and Odisha showed a 34 per cent reduction in the prevalence of anaemia.

Mild anaemia was the most common grade of anaemia in all the States in DLHS 4 and AHS CAB.

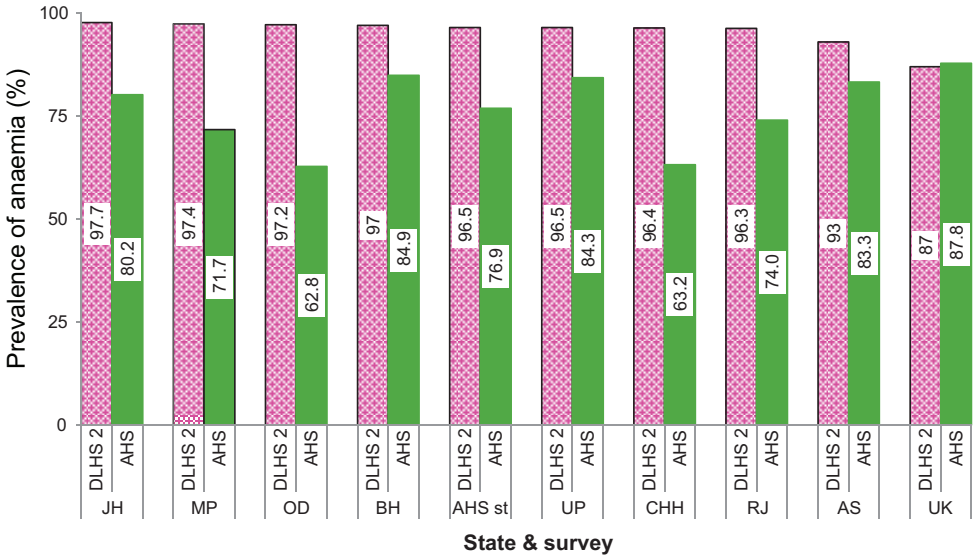

Fig. 5. Per cent prevalence of anaemia in District Level Household Survey 2 (DLHS 2) and Annual Health Survey (AHS). AS, Assam; BH, Bihar; CHH, Chhattisgarh; JH, Jharkhand; MP, Madhya Pradesh; OD, Odisha; RJ, Rajasthan; UP, Uttar Pradesh; UK, Uttarakhand, AHS st, Annual Health Survey States.
Source: Refs 15, 17.

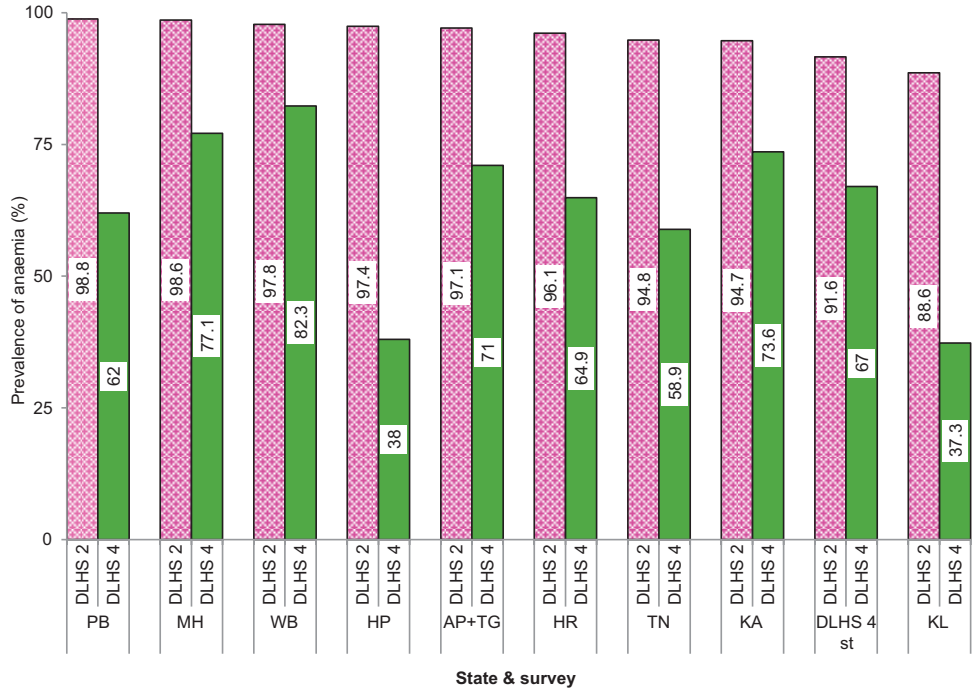

Fig. 6. Per cent prevalence of anaemia in District Level Household Survey (DLHS) 2 and 4. HR, Haryana; HP, Himachal Pradesh; KA, Karnataka; KL, Kerala; MH, Maharashtra; PB, Punjab; TN, Tamil Nadu; WB, West Bengal; AP+TG, Andhra Pradesh undivided; AP, Andhra Pradesh; TG, Telengana.
Source: Refs 15-16.

In all the States, there was a reduction in moderate anaemia between DLHS 2 and DLHS 4 and AHS CAB (Fig. 7A and B). The decline in prevalence and severity of anaemia was higher in DLHS 4 States as compared to AHS CAB States (Fig. 7A and B). These findings suggested that there was a substantial reduction both in the prevalence and severity of anaemia across all States; the magnitude of decline was higher in States with better antenatal care coverage.

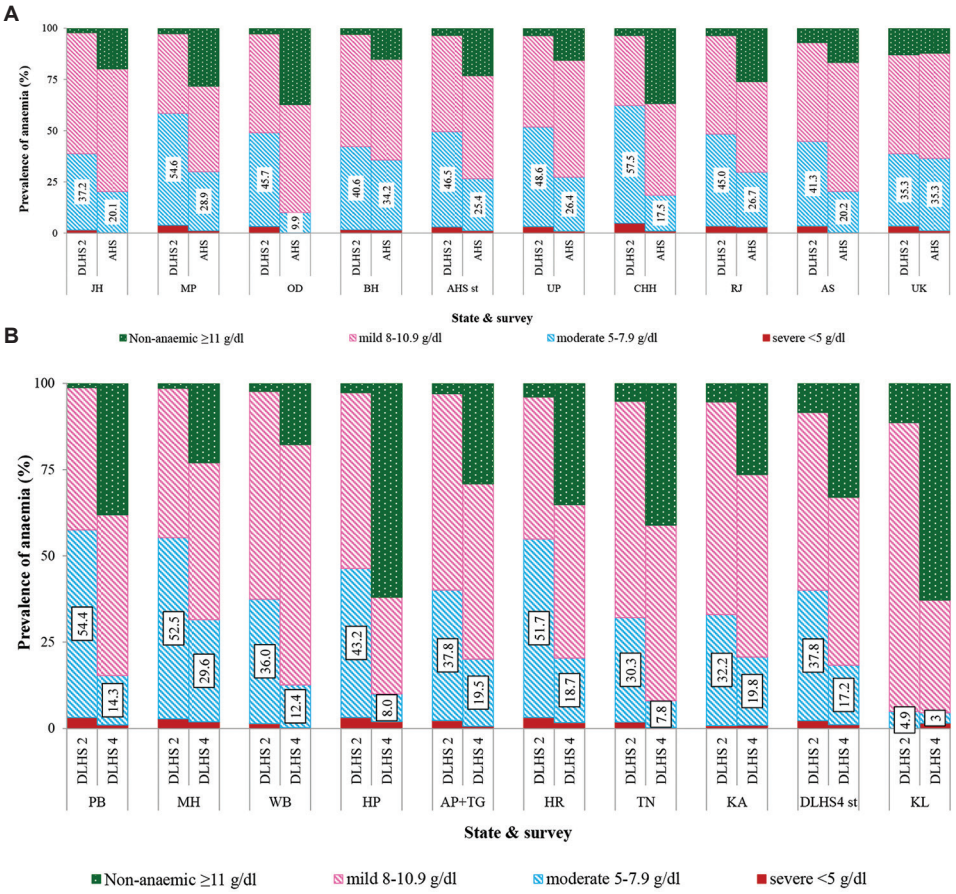

Fig. 7. (A and **B)** Changes in different grades of anaemia in District Level Household Survey (DLHS) 2, 4 and Annual Health Survey (AHS). AS, Assam; BH, Bihar; CHH, Chhattisgarh; JH, Jharkhand; MP, Madhya Pradesh; OD, Odisha; RJ, Rajasthan; UP, Uttar Pradesh; UK, Uttarakhand, AHS st, Annual Health Survey States; HR, Haryana; HP, Himachal Pradesh; KA, Karnataka; KL, Kerala; MH, Maharashtra; PB, Punjab; TN, Tamil Nadu; WB, West Bengal; AP+TG, Andhra Pradesh undivided; AP, Andhra Pradesh; TG, Telengana; DLHS4 st, District Level Household Survey 4 States.
Source: Refs 15-17.

Table II. Prevalence of anaemia and severe anaemia in neighbouring countries

Country	Per cent with Hb <11 g%	Per cent with Hb <7 g%
Afghanistan	44	1.2
Bangladesh	48	0.5
Bhutan	46	1.2
India	54	1.3
Maldives	39	0.6
Myanmar	33	0.7
Nepal	44	0.6
Pakistan	50	2.1
Sri Lanka	25	0.4
Thailand	30	0.6
Malaysia	27	0.4

Hb, haemoglobin. *Source*: Ref. 1.

Discussion

Data from NFHS 2, 3 and 4 indicated that about 50 per cent of pregnant women in India were anaemic, among South Asian countries India had the highest prevalence of anaemia in pregnancy (Table II).

At the national level and in most States, there was an increase in the prevalence of anaemia and moderate anaemia between NFHS 2 and 3. Between NFHS 2, 3 and 4, there was no clear trend of decline in the prevalence of anaemia in different States. In some States, such as Himachal Pradesh and Delhi, there was a rise in the prevalence of anaemia between NFHS 2 and 4. The lack of reduction in the prevalence of anaemia between the three surveys was attributed to poor implementation of the National Anaemia Control Programme (NACP) and National Iron Plus Initiative (NIPI) guidelines[11].

It is important to explore possible factors that might be responsible for the substantial difference in the reported prevalence of anaemia, as well as changes over time in prevalence of anaemia between the NFHS surveys and the DLHS and AHS surveys. Survey design, sampling procedure and sample size as well as margin of error around estimates assumed in different surveys can have strong bearing on the estimates of prevalence of any parameter. All national surveys are well designed; all these adopted a systematic, multi-stage stratified probability proportionate sampling. NFHS 2 and 3 were designed to provide State-level estimates of maternal and child health, nutrition and fertility parameters. The national level estimates were derived from the State level estimates. DLHS 2, 4 AHS and AHS-CAB and NFHS 4 were designed to provide district level estimates of health, nutrition and fertility parameters from which the State-level estimates were derived. The parameters used for calculating sample sizes required varied between surveys. In all the surveys, the computed sample sizes for the estimation of these parameters were more than adequate for the estimation of prevalence of anaemia in pregnancy. In all these surveys, every effort was made to minimize sampling and non-sampling errors. The differences between un-weighted and weighted number of cases and standard errors were very low in all these surveys. The differences in prevalence of anaemia in pregnancy both at the national and State level between NFHS 2, 3 and 4 on one side and DLHS 2, 4 and AHS CAB on the other, were large (beyond 25%) and were unlikely to be due to differences in the survey methodology.

The other possibility was that the observed differences were due to differences in the method used for Hb estimation between NFHS series and DLHS-AHS series. It was reported that correlation between HemoCue and complete blood count was better (r=0.73) in the 8.0-11.9 g/dl Hb range and poor (r=0.30, r=0.57) when Hb values were >12.0 g/dl and <8.0 g/dl respectively[22]. This study has also recommended that HemoCue may be used in emergency situation where immediate results are needed for making therapeutic decision but should be followed later by accurate method of Hb estimation[22]. Indian studies[23-26] showed that there was no linear correlation between Hb estimated by HemoCue and cyanmethaemoglobin methods; and HemoCue overestimated Hb and underestimated anaemia.

A survey conducted by Nutrition Foundation of India (NFI) in the same villages covered by NFHS 2 in 10 States, in which Hb estimation was done by cyanmethaemoglobin method showed that the prevalence of anaemia in pregnancy continued to be very high[27]. Reported prevalence of anaemia in the National Nutrition Monitoring Bureau (NNMB) micronutrient survey[28] was similar to reported prevalence of anaemia in NFI survey[27] and DLHS 2[15]. Analysis of the data from DLHS 4 & AHS CAB surveys has shown that during this period, there has been shift to the right in the frequency distribution of Hb levels in pregnancy[29]. Data from surveys using cyanmethaemoglobin method for Hb estimation (DLHS 2, 4 & AHS CAB) presented in this manuscript have shown that in the last 15 years, there has been a reduction in the prevalence and severity of anaemia in pregnant women.

What are the factors responsible for the improvement in Hb reported by the DLHS and AHS CAB surveys? Data from all these surveys indicated that there was some improvement in coverage under iron-folic acid supplementation (NFHS 3 15.2%, NFHS 4 30.3%); though screening for anaemia and appropriate management envisaged in the NACP[9] and in NIPI[11] guidelines had not been widely implemented. The prevalence and severity of anaemia were lower in States with higher coverage under antenatal care and IFA supplements. Therefore, improvement in antenatal care was one of the factors responsible for the improvement in Hb status. However, analysis on time trends in Hb in preschool children and adolescent girls from DLHS 2, 4 and AHS indicates that there has been some improvement in Hb and shift to the right in the Hb frequency distribution even though the coverage under IFA supplementation in these two groups have been very low[29]. During this period, there has been some improvement in dietary intake and reduction in under-nutrition rates in women. There has been some reduction in malaria and hookworm infestation both in endemic areas and across the country. These factors could also have contributed to the reduction in the prevalence of anaemia between 2004 and 2015.

There is an urgent need to further accelerate the rate of decline in anaemia in pregnancy. A two-pronged approach of universal testing and treatment of anaemia in pregnant women and measures for reducing anaemia before pregnancy may be required to achieve this goal. NACP as well as the NIPI envisaged screening of all pregnant women for anaemia using either Hb colour scale or Sahli's haemoglobinometer because these have been provided under the programme right up to subcentres across the country. Neither of these is accurate enough to grade anaemia or correctly assess impact of treatment. The recent

WHO antenatal care guidelines[30] do not advocate the use of Hb colour scale for screening for anaemia. India should also move away from using inaccurate Hb colour scale and Sahli's haemoglobinometer and use cyanmethaemoglobin method for accurate estimation of Hb. This will enable clinicians to implement NIPI guidelines for prevention and management of anaemia and monitor improvement.

The strength of the study was that it utilized the data on Hb levels in pregnant women reported from large-scale national surveys over the past two decades to assess time trends in the prevalence of anaemia in pregnant women. The limitation was that the study was based only on data from cross-sectional surveys.

In conclusion, data from surveys using cyanmethaemoglobin method for Hb estimation (DLHS 2, 4 and AHS CAB) have shown that in the last 15 years there has been a reduction in the prevalence of anaemia and moderate anaemia. The two-pronged strategy of increasing iron intake of the population (dietary diversification and use of iron-fortified iodized salt) and testing, detecting and treating pregnant women with anaemia, will accelerate the pace of reduction of anaemia in pregnancy.

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***Conflicts of Interest*:** None.

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