Original Research Article

Maternal hemoglobin: socio-demographic and obstetric determinants in rural Central India

Surekha Tayade*, Ritu Singh, Jaya Kore, Neha Gangane, Noopur Singh

Department of Obstetrics and Gynecology, Mahatma Gandhi Institute of Medical Sciences, Sewagram, Wardha, Maharashtra, India

*Correspondence:
Dr. Surekha Tayade,
E-mail: stayade@mgims.ac.in

ABSTRACT

Background: Maternal Anemia is a global health problem with adverse implications on materno-fetal outcome. Various socio-demographic and obstetric factors affect prevalence of anemia.

Methods: A hospital based, cross-sectional, observational study was carried out among pregnant women seeking antenatal care at Kasturba Hospital of MGIMS, Sewagram, a rural tertiary care institute in central India. Information was collected about demographic variables, age, gravidity, parity, literacy, area of residence and socioeconomic status. Hemoglobin levels in first trimester and pre delivery were measured by coulter and correlated with socio-demographic and obstetric factors.

Results: Among 500 pregnant women of first trimester, 249 (49.8%) had anemia, 154 (30.8%) mild, 86 (17.2%) moderate and 9 (1.8%) severe anemia. More women with anemia were of lesser age, resided in rural area, belonged to middle and lower economic class, lived with joint families and had less than 12 years of formal education.

Conclusions: Anemia is prevalent in pregnant women in this geographic region of central India. Age, higher gravidity, higher parity, rural residence, low socioeconomic status and less than 12 years of formal education, are risk factors. Appropriate age at marriage, small family norm, education of girl child, anemia prevention strategy in adolescent girls and financial empowerment of women are suggested strategies for prevention of anemia and improved maternofetal outcome.

Keywords: Demographic determinants, Maternal anemia, Obstetric factors, Pregnant women

INTRODUCTION

India is one of the countries with very high prevalence of anaemia in the world. Almost 58 per cent of pregnant women in India are anaemic and it is estimated that anaemia is the underlying cause for 20-40 per cent of maternal deaths in India. India contributes to about 80 per cent of the maternal deaths due to anaemia in South Asia.[1] Nutritional anaemia is a major public health problem in India and is primarily due to iron deficiency. According to NFHS-2 survey, prevalence rate of anaemia

in pregnancy is reported to be 49.7% and in NFHS-3, prevalence is 57.9%.[2,3] This reveals the increased prevalence of anaemia during pregnancy in recent years.[2]

Anaemia with haemoglobin levels less than 6 mg/dl is associated with poor pregnancy outcome. Mothers with nutritional or iron deficiency anaemia tend to deliver prematurely with low birth weight babies and with a high mortality rate or stillbirths, as compared to non-anaemic mothers.[4] The selective uptake of iron by the foetus cannot prevent the development of anaemia in the newborn, and thus it mandates abundant iron intake by

mothers during pregnancy, both in diet and in folic acid supplementation, to prevent the birth of anaemia and low birth weight children.[5] Various socio-demographic and obstetric factors such as age, age at marriage, parity, literacy, area of residence and socioeconomic status etc affect the hemoglobin status and contribute to maternal and fetal outcome. NFHS-2 study provides information that anemia is more prevalent in illiterate women (55.8%), while it is only 40.8% prevalent in women who have completed their high school studies.[2] NFHS-3 showed 51.5% prevalence of anemia in urban women and 58.2% in rural women.[3] The disease has been reported to be more prevalent in low socioeconomic status women (60.2%) in survey reported by NHFS-2 (2), while high socio-economical class women had 41.9% prevalence. Thus this study was carried out in rural India to know the relation between demographic determinant and maternal hemoglobin.

METHODS

Pregnant women in the first trimester, amenable for follow up, who visited the out patient department (OPD) or who were admitted in the maternity wards of the Obstetrics and Gynecology Department of Mahatma Gandhi Institute of Medical Sciences Sevagram, a rural based tertiary care hospital in eastern Maharashtra in central India were recrited in the study. The study took place over a period of 24 months (1st December 2012 to 30th November 2014). 500 consecutive, consenting pregnant women, regardless of age and parity, having singleton pregnancy were recruited. Approval from the institutional ethics committee was obtained and informed written consent was taken. Detailed history was taken regarding socio-demographic characteristics like age, area of residence, gravidity, parity, booking status, literacy and socioeconomic condition according to Kuppuswami's classification. 5ml of venous blood was drawn from the woman and haemoglobin (by electronic cell counter) estimation was done from the Hematology division of Pathology. Maternal Anemia was defined as hemoglobin levels less than 11 gram per dl. The severity was graded according to WHO classification.[6]

Table 1: Grades of anemia.

Severity of anaemia	Haemoglobin Level (gm/dl)
Mild anaemia	10-10.99
Moderate anaemia	7-9.9
Severe anaemia	<7

The hemoglobin was repeated when the woman reported to labor- delivery unit with labor pains and pre-delivery hemoglobin status was noted. The data was entered in excel sheet and analysis was done using SPSS software

RESULTS

The mean age was 23.52±3.03 years, with a minimum 18 and maximum 35 years (Table 2).

Table 2: Descriptive statistics for various parameters in study population.

Parameters	N	Minimum	Maximum	Mean	Std. deviation
Age (years)	500	18.00	35.00	23.52	3.03

Table 3: Comparison of first trimester hemoglobin with demographic factors.

| Demographic determinant | Normal n=251 (≥11gm/dl) | Anemic < 11 gm /dl | | | Test result | p-value |
		Mild n=154 (10-10.9gm/dl)	Moderate n=86 (79.9gm/dl)	Severe n= 9 (<7gm/dl)		
Age of Mother in years	23.95±3.20	23.24±3.08	22.59±2.12	25±2.29	5.67	0.001, S
Rural residence	131 (26.2%)	81 (16.2%)	43 (8.6%)	6 (1.2%)	0.93	0.81, NS
Urban residence	120 (24%)	73 (14.6%)	43 (8.6%)	3 (0.6%)		
Mother's education						
Illiterate	8 (1.6%)	7 (1.4%)	3 (0.6%)	0 (0%)		
Primary	38 (7.6%)	24 (4.8%)	18 (3.6%)	2 (0.4%)		
Secondary	109 (21.8%)	60 (12%)	41 (8.2%)	1 (0.2%)	17.37	0.13, NS
Graduation	89 (17.8%)	63 (12.8%)	24 (4.8%)	6 (1.2%)		
Postgraduation	7 (1.4%)	0 (0%)	0 (0%)	0 (0%)		
Nuclear family	81 (16.2%)	69 (13.8%)	35 (7%)	0 (0%)	12.22	0.007, S
Joint Family	170 (34%)	85 (17%)	51 (10.2%)	9 (1.8%)		
Socioeconomic status						
Lower	21 (4.2%)	15 (3%)	3 (0.6%)	0 (0%)		
Lower middle	7 (1.4%)	3 (0.6%)	6 (1.2%)	6 (1.2%)		
Middle	110 (22%)	66 (13.2%)	37 (7.4%)	3 (0.6%)	99.38	0.0001 S
Upper middle	49 (9.8%)	18 (3.6%)	11 (2.2%)	0 (0%)		
Upper	64 (12.8%)	52 (10.4%)	29 (5.8%)	0 (0%)		

Mean age of the mother in non-anemic women was 23.95±3.20 years and in anemic group it was 23.24±3.08 years for mild group, 22.59±2.12 years in moderate group and 25±2.29 years in severe group; by using z- test, statistically significant difference was found in age of mother (z=5.67, P=0.001) in first trimester, and also in pre delivery hemoglobin with Z=288, P=0.035 (Table 3 and 4).

Table 4: Comparison of first trimester hemoglobin with obstetric factors.

| Demographic determinant | Normal n=251 (≥11gm/dl) | Anaemic (<11gm/dl) | | | Test Result | p-value |
		Mild n=154 (10-10.9gm/dl)	Moderate n=86 (79.9gm/dl)	Severe n= 9 (<7gm/dl)		
Gravida One	157 (31.4%)	99 (19.8%)	46 (9.2%)	0 (0%)		
Gravida Two	75 (15%)	37 (7.4%)	27 (5.4%)	9 (1.8%)	33.59	0.001, S
Gravida Three	16 (3.2%)	18 (3.6%)	13 (2.6%)	0 (0%)		
Gravida Four or more	3 (0.6%)	0 (0%)	0 (0%)	0 (0%)		
Para 0	164 (32.8%)	105 (21%)	46 (9.2%)	6 (1.2%)		
Para 1	80 (16%)	46 (9.2%)	33 (6.6%)	3 (0.6%)	10.47	0.10, NS
Para 2 or more	7 (1.4%)	3 (0.6%)	7 (1.4%)	0 (0%)		
Booked	99 (19.8%)	72 (14.4%)	43 (8.6%)	0 (0%)	10.69	0.013, S
Unbooked	152 (30.4%)	82 (16.4%)	43 (8.6%)	9 (1.8%)		

In first trimester data, of total 500 women, 155 (31%) mothers in non-anemic group were primigravida, 75 (15%) were second gravida, 16 (3.2%) were gravida three and 3 (0.6%) fourth gravida whereas in anemic group, 99 (19.8%) primigravida were mildly anemic and 46 (9.2%) were having moderate anemia, none had severe anemia.

In second gravida, 37 (7.4%) were mildly anemic, 27 (5.4%) had moderate anemia and 9 (1.8%) had severe anemia. By using chi-square test statistically significant difference was found in gravidity of both the groups (x^2=33.39, P=0.001). This was also seen in pre- delivery hemoglobin with x^2=53.27, P=0.000 (Table 3 and 4).

Table 5: Comparison of pre-delivery hemoglobin with demographic factors.

| Demographic determinant | Normal n=158 (≥11gm/dl) | Anaemic (<11gm/dl) | | | Test Result | p-value |
		Mild n=190 (10-10.9g/dl)	Moderate n=137 (7-9.9g/dl)	Severe n=15 (<7g/dl)		
Age of the mother	23.98±3.37	23.32±2.80	23.13±2.94	24.60±2.22	2.88	0.035,S
Rural Residence	68 (13.6%)	108 (21.6%)	76 (15.2%)	9 (1.8%)	7.91	0.048, S
Urban residence	90 (18%)	82 (16.4%)	61 (12.2%)	6 (1.2%)		
Mother's education						
Illiterate	8 (1.6%)	4 (0.8%)	6 (1.2%)	0 (0%)		
Primary	23 (4.6%)	26 (5.2%)	30 (6%)	3 (0.6%)		
Secondary	65 (13%)	83 (16.6%)	60 (12%)	3 (0.6%)	28.71	0.004, S
Graduation	55 (11%)	77 (15.4%)	41 (8.2%)	9 (1.8%)		
Postgraduation	7 (1.4%)	0 (0%)	0 (0%)	0 (0%)		
Nuclear Family	60 (12%)	72 (14.4%)	53 (10.6%)	0 (0%)	9.10	0.028, S
Joint Family	98 (19.6%)	118 (23.6%)	84 (16.8%)	15 (3%)		
Socioeconomic status						
Lower	12 (2.4%)	15 (3%)	12 (2.4%)	0 (0%)		
Lower Middle	4 (0.8%)	6 (1.2%)	6 (1.2%)	6 (1.2%)		
Middle	63 (12.6%)	81 (1.6%)	69 (13.8%)	3 (0.6%)	60.06	0.0001, S
Upper Middle	36 (7.2%)	26 (5.2%)	14 (2.8%)	2 (0.4%)		
Upper	43 (8.6%)	62 (12.4%)	36 (7.2%)	4 (0.8%)		

In first trimester data, in non anemic women, 164 (32.8%) were nullipara, 80 (16%) were primipara and 7 (1.4%) were second para compared with mild anemic group where 105 (21%), 46 (9.2%) and 6 (1.2%) were

para 0, 1 and 2 respectively. By using chi-square test, statistically no difference was found in parity of the groups ($\aleph^2$=10.47, P=0.10). But in pre delivery hemoglobin statistical significance was found with $\aleph^2$=13.73, P=0.033 (Table 3 and 4). In non-anemic women, 99 (19.8%) were booked with the hospital and

152 (30.4%) were un booked compared to 82 (16.4%) of severe anemic that were un booked. There is statistical significant difference by using chi-square test in 1st trimester and also pre-delivery hemoglobin ($\aleph^2$=10.69, P=0.013; $\aleph^2$=8.56, P=0.036) (Table 3 and 4).

Table 6: Comparison of pre-delivery hemoglobin with obstetric factors.

Demographic Determinant	Normal n=158 (≥11gm/dl)	Anaemic (<11gm/dl)			Test Result	p-value
		Mild n=190 (10-10.9g/dl)	Moderate n=137 (7-9.9g/dl)	Severe n=15 (<7g/dl)		
Gravida One	100 (20%)	123 (24.62%)	76 (15.2%)	0 (0%)	53.27	0.0001, S
Gravida Two	48 (9.6%)	43 (8.6%)	42 (8.4%)	15 (3%)		
Gravida Three	7 (1.4%)	24 (4.8%)	16 (3.2%)	0 (0%)		
Gravida Four or more	3 (0.6%)	0 (0%)	0 (0%)	0 (0%)		
Para 0	101 (20.2%)	135 (27%)	79 (15.8%)	6 (1.2%)	13.73	0.033, S
Para 1	50 (10%)	52 (10.4%)	51 (10.2%)	9 (1.8%)		
Para 2 or more	7 (1.4%)	3 (0.6%)	7 (1.4%)	0 (0%)		
Booked	60 (12%)	75 (15%)	73 (14.6%)	6 (1.2%)	8.56	0.036, S
Unbooked	98 (19.6%)	115 (23%)	64 (12.8%)	9 (1.8%)		

In normal haemoglobin, 131 (26.2%) women were from rural area and 120 (24%) were urban. In anemic women residing in rural area, 81 (16.2%) had mild anaemia, 43 (8.6%) had moderate and 6 (1.2%) had severe anaemia. Of urban area 73 (14.6%) had mild, 43 (8.6%) had moderate and 3 (0.6%) had severe anaemia (first trimester data). The difference was significant in pre-delivery hemoglobin with $\aleph^2$ =7.91, P=0.048 (Table 3 and 4). Of the non-anaemia women, 109 (21.08%) were educated up to secondary school compared to 60 (12%) in mild anaemic group, 41 (8.2%) in moderate and 1 (0.2%) in severe anaemia group. The difference between non anaemic and anaemic group was statistically significant both in first trimester and pre delivery haemoglobin ($\aleph^2$ =12.95, P=0.012; $\aleph^2$ =28.71, P=0.004). Thus. education does play a major role in amelioration of anaemia (Table 3 and 4). Most non anemic women, 22% (110 of 251) belonged to socioeconomic class 3 (lower middle). The difference in between the groups regarding socioeconomic class was statistically significant both in the 1st trimester and pre-delivery hemoglobin groups ($\aleph^2$ =51.32, P=0.00, $\aleph^2$=60.06, P=0.00) (Table 3 and 4).

DISCUSSION

The present study was carried out on 500 pregnant women reporting to the maternity care unit of a tertiary rural hospital. The mean age of mother was 23.52±3.03 years, with a minimum of 18 and maximum of 35 years. A study done by Koepp et al showed a mean age of 30±3 and Ota et al in a WHO study showed a mean age of 27.9±5.3 years while Kirchengast et al found it to be 26.2±5.4 years.[7-9] An Indian study by Kader et al and Moghaddam et al showed a mean age of 25.9±4.9 and

26.4±5.6 years respectively.[10,11] Another study done in Maharashtra by Deshpande et al found a mean age of 22.7 ± 2.92 years.[12] The mean age in our study is less compared to others. This would be because there is a trend of early marriages in the area. The young married women became pregnant immediately after marriage with resultant teenage pregnancies and complications thereof. Similar observations were reported by Viveki in which the mean age of marriage was 19.25 years and that of first pregnancy was 21.77 years.[13]

The issue of age and anemia is debatable. While various studies have found a correlation between age and anemia, in some studies, investigators had not found any significant difference in the age of anemic and non-anemic women.[13-18] One study has found a significant difference of age in the studied population where the mean age of anemic population was 25.8+5.6 as compared to the non-anemic population (27.5±6.0 kg) (p value 0.017).[19]

Consistent with it, in the present study mean age of the mother in Pre pregnancy non-anemic women was 23.95±3.20 and in anemic group it was 23.24±3.08 for mild group, 22.59±2.12 for moderate group and 25±2.29 in severe anemia group with a significant difference (z=5.67, P=0.001) and significance was also there with pre-delivery hemoglobin (Z=2.88, P=0.035). The burden of disease was also correlated with age by Looker et al who indicated that anemia was a serious US public health problem, affecting up to 16% of females between the ages of 12-49 years.[20,21] Furthermore, data from the National Health and Nutrition Examination Survey (NHANES 1999–2000) study indicates that the overall

prevalence of iron deficiency anemia is highest in females between the ages of 20-49 years.[22]

Every successive pregnancy has an additive effect on anemia. The risk of anemia is increased nearly 3-fold in women with 2-3 children and nearly 4 fold greater for women with 4 or more children.[20] In the present study, it was observed that, population of primigravida with anemia constituted 60.4%, among whom 48.01% were having Hb <11gm%. It was also found that there was a trend of increasing severity of the anemia with gravidity. Pre-conceptional iron status of women plays an important role in anemia, which becomes poorer as number of pregnancy increases.

Of the total primigravida with anemia, only 48.01% were having Hb level <11gms but in the gravida 3 or more 65.95% (of total gravid 3) had anemia. However, incidence of grand-multipara is significantly decreasing in the area of study because of good health education and propaganda of only two children. The present study findings are consistent with the studies of Looker et al and Muhammad et al who reported higher prevalence of anemia in multiparous women.[20,23] Few studies suggest that gravidity and parity do not affect the degree of anemia significantly.[18,24]

In the present study, 52.20% of anemic women were living in rural area and 47.79% were from urban area. These findings co-relate well with the findings of NFHS 2 and 3. According to NFHS 3, 57.9% pregnant women were anemic; 54.6% in urban and 59% in rural.[3] Of these 35% were mildly anemic, 15% moderately anemic and 2% severely anemic. According to NFHS-2 survey, rural women population has higher prevalence rate of anemia i.e. 53.9% compared to urban women population i.e. 51.5%.[2]

It has been stated that low educational standards contributes to high prevalence of iron deficiency.[25] Scholl et al on comparing the educational levels in his study population stated that <12 years of education imposes 2-fold or more risk for anemia.[26] Similarly in the present study it was observed that, 20.4% of the study population who were anemic were educated up to secondary level, meaning less than 12 years of education indicating that quite a large number of anemic women had an education of less than 12 years. This shows that the health education in rural India needs to be addressed more efficiently as early as in the primary, secondary and higher secondary schools as many of the women are not able to get further education.

Nutrition and health classes need to be included in the school syllabus. Even women who completed graduation were found to be anemic in the present study as 18.6% of anemic women were graduates. Thus, apart from health awareness, other socio-economic and cultural factors should be looked into in order to improve the nutrition of women. These findings are similar to other studies conducted in the western world, where there is a declining trend towards anemia after 12 years of education.[26] Bulliyyet al while studying anemia in adolescent girls in Orissa, India observed significant association between anemia and their levels of education.[27] Muhammad et al in Pakistan also noted that there is a negative impact of levels of education on anemia.[23]

Present study found that anemia was more common in women from joint families compared to nuclear families. The possible reason for the above observation could be sharing of food among more family members in the joint family structure and women being the last to have food as a part of culture and tradition, gets less calories as compared to her counterpart in the nuclear families. Similar Findings were noted by Viveki et al and Lokare et al.[13,15]

Socioeconomic status does have a negative impact on the nutrition and hence it has a positive association with anemia. In the present study, majority of anemic women belonged to middle class and lower class. Czajka et al, Grantham et al and Viveki has established a positive correlation between low socioeconomic status and high prevalence of anemia.[13,25,28] If comparison between economic classes is made, anemia was significantly higher in lower socioeconomic class (p<0.05). The negative impact of low socioeconomic status on anemia in pregnancy was also studied by Bodnar et al.[29]

Cooket al noted that it was a global problem, mainly affecting poor people in the developing countries.[30] Muhammad et al in Pakistan also found linear relationship of anemia with poor socioeconomic status.[23] Chaudhary et al also observed that there is a high prevalence of anemia amongst adolescent females of lower socioeconomic strata.[31] In the present study, a significant association of anemia was found with socioeconomic status, which may be due to the availability of high quality nutritious food with better socioeconomic status. Age, higher parity, joint families, poor literacy and lower socioeconomic status thus showed correlation with maternal anemia.

CONCLUSION

There is high prevalence of maternal anemia in rural central India. Anaemia in pregnancy is associated with several social and demographic factors. Lower maternal age, higher gravidity and parity, education of less than 12 years, joint family and poor socioeconomic condition are social and obstetric determinants correlating with anemia. It is suggested that age at marriage and age at first pregnancy should be appropriate so that good nutrition is ensured.

Iron prophylaxis should be provided for adolescent girls to reduce number of anemic mothers in the beginning of their conception. Proper care and education of girl child

will assure nutrition of whole family when she marries and has her own family, and anemia can be prevented. Women should be economically empowered and good antenatal care must be made available and accessible in pregnancy. The socio-economic status of women should be enhanced in line with the Millennium Development Goals which asserts that eradicating extreme poverty, reducing child mortality rates, improving maternal health, fighting disease epidemics such as AIDS, and developing a global partnership for development are imperative and should be achieved within a timeline. It is hoped that this initiative will help prevent anaemia and enhance pregnancy outcomes.

REFERENCES

1. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ. Selected major risk factors and global and regional burden of disease. Lancet. 2002;360(9343):1347-60.
2. NFHS-2. National family health Survey. India, Mumbai: Indian instituite of population studies; 2000.
3. National Family health Survey (NFHS-3)-. International institute for population Sciences (IIPS) and Macro International.2007. India, Mumbai:IIPS2007.
4. Khan M. Effect of maternal anaemia on fetal parameters. JAMC. 2000;13(2):38-41.
5. Balai K, Pendse V, Gupta R, Gupta S. Effect of maternal anemia on iron status of the new born. Indian J Maternal Child Health. 1992;3(2):54-6.
6. WHO. Iron deficiency anaemia: assessment, prevention and control: a guide for programme managers. 2001.
7. Stamnes Koepp UM, Frost Andersen L, Dahl-Joergensen K, Stigum H, Nass O et al. Maternal pre- pregnant body mass index, maternal weight change and offspring birthweight. Acta Obstetricia Gynecologica Scandinavica. 2012;91(2):243-9.
8. Ota E, Haruna M, Suzuki M, Anh DD, Tho LH, Tam NTT, et al. Maternal body mass index and gestational weight gain and their association with perinatal outcomes in Viet Nam. Bull World Health Organization. 2011;89(2):127-36.
9. Kirchengast S, Hartmann B. Determinants of gestational weight gain with special respect to maternal stature height and its consequences for newborn vital parameters. Anthropologic Rev. 2013;76(2):151-62.
10. Kader M, Perera NKP. Socio-economic and nutritional determinants of low birth weight in India. North Am J Med Sci. 2014;6(7):302.
11. Moghaddam Tabrizi F, Saraswathi G. Maternal anthropometric measurements and other factors: relation with birth weight of neonates. Nutr Res Pract. 2012;6(2):132-7.
12. Deshpande Jayant D, Phalke D, Bangal V, D Peeyuusha BS. Maternal risk factors for low birth weight neonates: a hospital based case control study in rural area of western maharashtra, India. Natl J Comm Med. 2011;2(3):394-8.
13. Viveki R, Halappanavar A, Viveki P, Halki S, Maled V, Deshpande P, et al. Prevalence of anaemia and its epidemiological determinants in pregnant women. Al Ameen J Med Sci. 2012;5(3):216-23.
14. Ahmad J, Baba T, Shoib S, Ahmad A, Ashraf M, Ahmad R. Anemia in pregnant women in a rural block of Kashmir valley: Its prevalence and socio-demographic associates. Int J Med Sci Public Health. 2013; 2(4):814-8.
15. Lokare PO, Karanjekar VD, Gattani PL, Kulkarni AP. A study of prevalence of anemia and sociodemographic factors associated with anemia among pregnant women in Aurangabad city, India. Annal Nigerian Med. 2012;6(1):30.
16. Singh A, Kandpal S, Chandra R, Srivastava V, Negi K. Anaemia amongst pregnant and lactating women in district Dehradun. Ind J Prev Soc Med. 2009;40:19-22.
17. Frith-Terhune AL, Cogswell ME, Khan LK, Will JC, Ramakrishnan U. Iron deficiency anemia: higher prevalence in Mexican American than in non-Hispanic white females in the third National Health and Nutrition Examination Survey, 1988-1994. Am J Clin Nutr. 2000;72(4):963-8.
18. Geelhoed D, Agadzi F, Visser L, Ablordeppey E, Asare K, O'Rourke P, et al. Severe anemia in pregnancy in rural Ghana: a case–control study of causes and management. Acta Obstetricia et Gynecologica Scandinavica. 2006;85(10):1165-71.
19. Petersen LA, Lindner DS, Kleiber CM, Zimmerman MB, Hinton AT, Yankowitz J. Factors that predict low hematocrit levels in the postpartum patient after vaginal delivery. Am J Obstet Gynecol. 2002;186(4):737-44.
20. Looker AC, Dallman PR, Carroll MD, Gunter EW, Johnson CL. Prevalence of iron deficiency in the United States. JAMA. 1997;277(12):973-6.
21. Control CfD, Prevention. Iron deficiency--United States, 1999-2000. MMWR. 2002;51(40):897.
22. eople USDoHaHSH. With understanding and improving health and objectives for improving health. In: Department of Health and Human Services, editor. Washington DC:U.S;2010.
23. Idris M. Iron deficiency anaemia in moderate to severely anaemic patients. JAMC. 2004;17(3):45-7.
24. Carles G, Tobal N, Raynal P, Herault S, Beucher G, Marret H, et al. Doppler assessment of the fetal cerebral hemodynamic response to moderate or severe maternal anemia. Am J Obstet Gynecol. 2003;188(3):794-9.
25. Grantham-McGregor SM, Powell CA, Walker SP, Himes JH. Nutritional supplementation, psychosocial stimulation, and mental development of stunted

children: the Jamaican Study. Lancet. 1991;338(8758):1-5.

26. Scholl TO. Iron status during pregnancy: setting the stage for mother and infant. Am J Clin Nutr. 2005;81(5):1218S-22S.

27. Bulliyya G, Mallick G, Sethy GS, Kar SK. Hemoglobin status of non-school going adolescent girls in three districts of Orissa, India. IJAMH. 2007;19(4):395-406.

28. Czajka-Narins DM, Haddy TB, Kallen DJ. Nutrition and social correlates in iron deficiency anemia. Am J Clin Nutr. 1978;31(6):955-60.

29. Bodnar LM, Cogswell ME, Scanlon KS. Low income postpartum women are at risk of iron deficiency. J Nutr. 2002;132(8):2298-302.

30. Cook J. The nutritional assessment of iron status. Arch Latinoam Nutr. 1999;49(2):11S.

31. Chaudhary SM, Dhage VR. A study of anemia among adolescent females in the urban area of Nagpur. Indian J Comm Med. 2008;33(4):243.