

## Prevalence of Anemia among Adolescent Girls and Adult Women of Tea Garden Areas of Darjeeling and Jalpaiguri Districts of West Bengal

Prabir Kumar Manna<sup>1</sup> and Debidas Ghosh<sup>2\*</sup>

<sup>1</sup>*Department of Physiology, Siliguri College, Siliguri, Darjeeling, West Bengal, India*

<sup>2</sup>*Department of Bio-Medical Laboratory Science and Management, Vidyasagar University, Midnapore 721 102, West Bengal, India*

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**ABSTRACT** The study was undertaken to assess the prevalence of anemia among adolescent girls and adult women, and the importance of different variables on anemia in some rural belts of North Bengal. Body Mass Index (BMI) was calculated and hemoglobin levels of the subjects were measured. It was found that 60.76 % female have normal BMI, 4.49% female were obese and 34.74% showing thinness. The percentages of mild, moderate and severe anemia were respectively 39.49%, 35.00% and 6.73%. Variables like education, family income, BMI, personal hygiene, worm infection, dietary habit, malaria, iron and folic acid (IFA), symptoms like headache, fatigue, and dyspnoea were significantly related with anemia. The study also revealed that females of tea garden areas of the two districts were suffering more from anemia. Initiatives must be taken by the health centers to improve personal hygiene, knowledge of diet, IFA consumption and to prevent

### INTRODUCTION

Anemia is very common in India, particularly among the women of the poor economic section of the country. It is the most widespread yet most neglected micronutrient deficiency disorder in India. It is very harmful for community health. The study by Balducci (2003) and Nisenson et al. (2003) showed that anemia is a common clinical problem at all ages, but this is especially true among the elderly. The report of NFHS-3 (2005-06) shows that: "Anemia is such a serious health problem in India which may have detrimental effect on the health of adolescent and women." One study in rural sector of Tamil Nadu by Rajaratnam et al. (2000) also showed that the prevalence of anemia among adolescent girls and women is due to micronutrient deficiency. The study by Izaks et al. (1999) and Landi et al. (2007) showed that undiagnosed or untreated anemia is associated with an increased risk of mortality and the study by Dharmarajan

et al. (2006) showed that anemia is associated with decreased quality of life. Gabrilove (2005) showed that anemia also causes fatigue and leads to negative impact on cognitive and physical functions as well as on the quality of life, thereby serves as a marker of increased vulnerability. According to Singh et al. (1999), anemia is directly associated with malaria. A study by Hawdon et al. (1996) showed that hookworms cause severe anemia in developing countries of the tropics, with an estimated one billion people infected worldwide. The report of NFHS-2 showed that in India 51.8% women suffer from anemia.

The report of NFHS-3 highlighted that "Anemia is considerably higher for rural women (52%) than the urban women (46%). By caste, scheduled tribe women have the highest level of anemia (65%) followed by the scheduled caste women (56%). The working women are more prone to anemia than non-working women. Women who eat fruit at least once in a week are less likely to be anemic than women who eat fruit less often or not at all". Anemia is associated with reduction in work capacity and increased susceptibility to infection. Study conducted in Shimla by Goel et al. (2007) noted that worm infection is significantly related to anemia. Allen (2000) found that severe anaemia during pregnancy is an important contributor to maternal mortality. Ac-

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\*Address for correspondence:

Dr. Debidas Ghosh

Professor and Head

Department of Bio-Medical

Laboratory Science and Management

Vidyasagar University

Midnapore 721102, West Bengal, India

E-mail: debidas\_ghosh@yahoo.co.in

cording to Steer (2000) and McCormick (1985), anemia causes low birth weight which is in turn an important risk factor for infant mortality.

Females working in the tea gardens of the two districts of North Bengal are poor, less educated, mostly scheduled tribes and castes. The work in the tea gardens is their source of income. Anemia may decrease the work capacity, birth weight, increase maternal and infant mortality and that seriously affects the families. Terai and Dooars regions of the two districts are more prone to malaria and worm infection. In this connection there is always a chance of higher prevalence of anemia and its serious effects among the female workers of the two districts. To get a clear idea of the different degree of anemia among adolescent girls and adult women, and to find out the role of different variables in the development of anemia, the present study was carried out.

### EXPERIMENTAL DESIGN

A household survey was conducted between January-2008 to April 2009 through a pretested interview schedule to determine the different grades of anemia and the role of different factors in the progression of anemia. Adolescent girls and adult women of low socio-economic groups of tea garden areas of Darjeeling and Jalpaiguri districts were considered for the collection of data. Data were collected by multi-stage random sampling from the Matigara and Phansidewa Blocks of Siliguri Subdivision and Rajganj Block of Jalpaiguri Sadar Subdivision. All females from the selected villages between 11 to 49 years of age were included in the sample. In the first stage, the girls of 11-17 years age were considered as adolescent group and the women of 18-49 years of age were considered as adults. In the second stage both the groups were classified into mild, moderate, severe anemia and normal categories.

The researchers got the response of 757 females out of which 364 were adolescent girls and 393 were adults. Height and weight were measured respectively by the method of Lohman et al. (1988). Body mass index (BMI) was computed from the height and weight using the following equation  $BMI = \text{weight (kg)} / \text{height (m}^2\text{)}$ .

Hemoglobin was measured by cyanmethemoglobin method of Prakash et al. (1972). According to World Health Organization (1992) cri-

teria, anemia is considered when hemoglobin level is less than 12g/dl and on that basis different grades of anemia were classified. The subjects were asked about their age, education, family income, personal hygiene, worm infection, dietary habit, IFA, malaria and symptoms of anemia like- headache, fatigue, dyspnoea, etc. The malaria and worm infection and symptoms of anemia were taken into consideration if the subjects suffered within two months of the date of survey. The diet taken by the subjects during the last one week were considered to find out the amount of green leafy vegetables, meat and fruits in their diet as the source of iron and protein. For grading personal hygiene, a scoring system was devised based on regular bath, cleaning of hair, washing of hands before meals, cleanliness of clothes, footwear, trimming of nails, presence of lice and skin diseases etc. The scores in the form of 0, 1 and 2 were given respectively for non-hygienic level, moderate hygienic level and full hygienic level. If any subject gets 50 % or more of the total score then they were included in hygienic group and the subjects with below 50% score were included in non-hygienic group. Out of 757 subjects, 60 subjects were consuming adequate foodstuff and 697 subjects were suffering from inadequate intake of foodstuff. 629 subjects of 757 showed anemia symptoms and 128 subjects were normal. Only 115 subjects of 757 had taken iron and folic acid. Subjects with inadequate food intake, anemia symptoms, and history of folic acid consumption were considered as variables in the Table.

The obtained data was statistically analysed to see the role of different variables on anemia. The level of significance was calculated using Chi square test.

### OBSERVATION

The average income of three to five members' family was Rs. 2000/- month. The researchers found that the educational status of the subjects was very poor. Only 1.92% adolescent girls were students of class XI or above, 54.39% were not going to the school and rest were school-going girls. Body mass index is one of the good indicators of health status of the individual. Table 1 showed the BMI status of the adolescent and adult women. Adolescent girls were having very less (3.3%) percentage of obe-

**Table 1: Body mass index (BMI) of the subjects**

Category	Under nutrition (BMI below 18.5)	Normal (BMI range 18.5-25.0 )	Obesity (BMI above 25.0 )
Adolescents (364)	115 (31.59%)	237 (65.11%)	12 (3.30%)
Adults (393)	148 (37.66%)	223 (56.74%)	22 (5.59%)
Total (757)	263 (34.74%)	460 (60.77%)	34 (4.49%)

sity (above-25) than the adults (5.4%). The adult women were having more percentage (37.66%) of BMI range below 18.5 than the adolescent girls (31.59%).

Table 2 showed that 79.95% adolescent and 82.45% adult women were anemic. The highest percentage of severe and moderate anemia was noted in adult women. Percentages of normal and mild anemia were higher in adolescents.

Table 3 showed some selected pretested variables and the results focused the significant re-

lationship of those variables with anemia. The results showed that absence of education was one of the important causative factors of anemia. The prevalence of anemia was high in illiterate group and less in secondary or above educated group. The results showed that the females from the families with monthly income up to Rs.2000/- were suffering more from anemia than the females from the families with monthly income above Rs.2000/-. The researchers found that personal hygiene was significantly related

**Table 2: Percentages of mild, moderate and severe anemia among adolescent girls and adult women**

Category	Severe anemia (Hb<8g/dl)	Moderate anemia (Hb=8-10g/dl)	Mild anemia (Hb=10.1-12g/dl)	Normal (Hb>12g/dl)
Adolescents	21(5.77%)	109(29.94%)	161(44.23%)	73(20.06%)
Adults	30(7.63%)	156(39.69%)	138(35.11%)	69(17.55%)
Total	51(6.73%)	265(35.00%)	299(39.49%)	142(18.75%)

**Table 3: Relationship of different variables with anemia**

Variables (Subject no.)	Type	Non-anemic group	Anemic group	P value
Education(757)	1. Illiterate	43	212	$\chi^2 = 12.576$ P<0.01
	2. Primary	64	324	
	3. Secondary	35	79	
Income(757)	1. UptoRs-2000/month	83	486	$\chi^2 = 15.973$ P<0.001 $\chi^2 = 15.973$ P<0.001
	2. AboveRs- 2000/month	83	486	
		59	129	
Personal hygiene(757)	1. Hygienic	78	102	$\chi^2 = 85.233$ P<0.0001
	2. Non-hygienic	64	513	
Worm infection(757)	1. Present	73	385	$\chi^2 = 6.048$ P<0.02
	2. Absent	69	230	
Foodstuff. (inadequate-697)	1. Green leafy veg.	33	134	$\chi^2 = 5.479$ P<0.02
	2. Meat and fruits	50	197	
	3. Both.	39	244	
Symptoms (629)	1. Headache	21	272	$\chi^2 = 57.298$ P<0.0001
	2. Fatigue	32	207	
	3. Dyspnoea	37	60	
BMI (757)	1. Below 18.5	25	238	$\chi^2 = 35.93$ P<0.0001
	2. 18.5 -25	101	359	
	3. Above 25	16	18	
IFA (Iron)	1. Received(72)	29	43	$\chi^2 = 5.264$ P<0.05
Folic acid( 115)	2. Partially received( 43)	07	36	
Malaria (757)	1. Yes	05	61	$\chi^2 = 5.93$ P<0.02
	2. No	137	554	

to anemia. Subjects maintaining good personal hygiene were less prone to anemia than the subjects who did not maintain good personal hygiene. The subjects with a history of worm infection in the last two months or suffering from the infection, was showing higher percentage of anemia than the non-infected subjects. Study showed that inadequate green leafy vegetables, meat and fruit in the diet are directly related to anemia. The subjects with both type of inadequate diet were much more prone to anemia. Symptoms like headache, fatigue and dyspnoea showed significant relationship with anemia. Body mass index (BMI) was also related to anemia. Subjects with low BMI were suffering more from anemia than the subjects with relatively higher BMI. Subjects took 100 or more Iron and Folic acid (IFA) showed less percentage of anemia. Subjects with a history of malaria disease within two months of the survey were showing higher percentage of anemia. Nutrients like protein, iron, vitamin-C and energy consumption by the subjects are highlighted in Table 4. It showed that the percent adequacy for energy is 80.14 in adolescents and 77.17 in adult women. The percent adequacy for protein is 61.69 in adolescent and 74.88 in adult women. Adolescents and adult women showed respectively the percent adequacy 68.57 and 77.63 for iron. The percent adequacy for vitamin-C was 72.30 in adolescents and 72.10 in adult women.

### DISCUSSION

The study focused that the percentage of anemia in adult women was 82.45%. Out of which 39.49% were suffering from mild anemia, 35.00% were suffering from moderate anemia and 6.73% were suffering from severe anemia which was higher than the NFHS-3 report for West Bengal. The NFHS-3 report focused that 65.6% of mar-

ried rural women of 15-49 years of age were suffering from anemia in West Bengal. One study by Pandit et al. (2005) showed that 77.7% of women were anemic out of which 25.86% women were moderate anemic and 5.2% were severe anemic. This study also focuses that the females are suffering more from moderate and severe anemia. Lesser intake of iron and first class protein for a long period of time by the females may be the cause of development of large number of moderate and severe anemic females.

The study also indicated that 79.95% adolescent girls were suffering from anemia. Study conducted in West Bengal by Das et al. (2005) and in other developing countries by Shah et al. (2002), and Agha et al. (1992) have shown a high prevalence of anemia in adolescents, that is, between 25% to 88%. One study in Madhya Pradesh by Gawarika et al. (2006) indicated that overall prevalence of anemia among the adolescent girls of weaker economic group is 96.5%. Study of Gawarika et al. (2006) also focus that prevalence of severe anemia among the adolescent girls of weaker income group in Madhya Pradesh is 11 %. Bulliyy et al. in 2007 found 96.5% prevalence of anemia among non-school going adolescent girls in three districts of Orissa of which 45.2%, 46.9% and 4.4% had mild, moderate and severe anemia. The result of our study is also consistent with the previous.

Study by Gawarika et al. (2006) also showed that the education of mother is significantly related to anemia. This study also focused on the significant relationship of educational level with anemia ( $p < 0.01$ ). Educated women probably are more serious about the health status than the uneducated women and that may be the cause of low prevalence of anemia in educated group. Economy of women is also significantly related ( $p < 0.001$ ) to anemia and that has been focused here. Women of poor economic class did not get required amount of iron containing food and first

**Table 4: Average daily consumption of specific nutrients**

Nutrient	Adolescent girl		Adult women	
	Consumed	RDA	Consumed	RDA
Energy(k cal)	1651.04	2060	1716.59	2225
Protein(g)	40.1	65	37.44	50
Iron(mg)	19.2	28	23.29	30
Vit-C	29.32	40	29.4	40

RDA= Recommended dietary allowances

class proteins, which are required for the synthesis of hemoglobin. A USA- based survey by Bodnar et al. (2001) also focused on the high prevalence of anemia among the low income group. A very limited income earned by the women in the tea gardens prevents them from consuming the foodstuffs containing first class protein and that makes them less efficient in work. A study by Li (1993) also observed that compared with non-anemic women, anemic women workers in China were 15% less efficient in performing their work. Diet survey and dietary analysis showed that the intake of nutrients like protein, iron, vitamin-C and energy is much less than the recommended amount. The researchers know that these nutrients play a vital role in work capacity. So the lesser intake of nutrients on a regular basis may be responsible for more percentage of anemia and low work capacity of rural women.

This study also highlighted a significant relationship of anemia with personal hygiene ( $p<0.001$ ). A study conducted in Shimla by Goel et al. (2007) showed that personal hygiene was significantly related to anemia and this is consistent with our observation. The females working in the tea gardens of North Bengal were very careless in their lifestyle. They were not habituated with regular bath, cleaning of hairs, washing of hands before meals, cleanliness of clothes, footwear, etc. The presence of lice and skin diseases were very common in the females.

The poor females were continuously suffering from worm infection. The blood loss in intestines due to worm infection in connection with less available pure drinking water increases the severity of anemia. The researchers found that worm infection was significantly related to anemia ( $p<0.02$ ) and the reports by Verhoeff et al. (1998) and Chakma et al. (2000) were similar with the results of the present study. This study also focused that the consumption of green leafy vegetables are significantly related to anemia ( $p<0.02$ ). Diet survey indicated that 58.12% women consumed the required amount of green leafy vegetables. The working women did not have the money to buy and cook more than one vegetable and fruit. Green leafy vegetables were freely available in the garden area but many of them did not like those vegetables and many did not have the time to bring them and cook. So the lesser intake of green leafy vegetables on a regular basis may cause high percentage of anemia than the report of NFHS-3 for rural women. The

result of some studies by Vasanthi et al. (1994) and Scholl et al. (1992) are also consistent with the researchers observation.

The researchers found that the signs and symptoms viz. headache, fatigue and dyspnoea are significantly ( $p<0.0001$ ) more prevalent in anemic subjects. Study conducted in Shimla by Goel et al. (2007) also noted that those symptoms were more prevalent in anemic groups. Poor females of the study area were consuming fewer amounts of both macronutrients and micronutrients. This causes deficiency of energy, protein and minerals and development of anemia. So the supply of required nutrient may prevent anemia.

The NFHS-3 report said that 44.9% women of 15-49 years of age with BMI range below normal were suffering from anemia. This study focused that 86.44 % of women with BMI range below normal were suffering from anemia. So the result of the present study is much higher than the NFHS-3 report. The researchers also found that the BMI is significantly related ( $p<0.001$ ) to anemia and which is parallel to the study by Jinabhai et al. (2001). Baig-Ansari et al. (2008) found that non-anemic women were significantly taller, weighed more, and had a higher body mass index than anemic women of Pakistan. Choi et al. (2004) also stated that body mass index of females with anemia was significantly lower than those with normal hemoglobin level. The deficiency of nutrients as well as anemia was causing less physical growth in adolescents. Adult females were also suffering from nutrient deficiency and failed to maintain age specific body weight and normal hemoglobin level. The low Himalayan belt of the Darjeeling and Jalpaiguri districts were popularly known as highly malarious belt. Every year many people die from malaria in this area. The researchers found that the subjects who suffered from malaria within two months of the survey, developed anemia ( $p<0.02$ ) and that was also reported by Murthy et al. (2000).

Regarding the dietary cause of anemia, an attempt was made to find out the role of iron and folic acid (IFA) with anemia. The researchers found that some women consumed IFA regularly and suffer less from anemia than the women who did not consume IFA regularly ( $p<0.05$ ). One study by Charoenlarp et al. (1988) showed that the IFA consumption and anemia were directly related. The diet of the females was not



supplying the essential nutrients like vitamin-C, iron and folic acid and for this they were suffering more from different grades of anemia. The study by Rajagopalan (2003) showed that micronutrient intervention was necessary for school going children to fight with anemia. More iron and folic acid consumption was required to decrease the percentages of anemia.

### CONCLUSION

It may be stated that the prevalence rate of anemia in this area is more than the national level of anemia percentage of adolescent and adult women. This may be due to less education, low income, poor personal hygiene, inadequate diet, worm infection, low BMI, malaria, lack of knowledge etc. Frequent awareness campaign can improve the knowledge of the females about anemia and its severity. The possible effects like weakness, low productivity, abortion, still birth etc. must be discussed with females so that they become more serious to overcome anemia. ICDS programme, Rural Health Mission, hundred days work etc. are helpful to improve the status of the rural families. The ongoing programmes must be undertaken so seriously that all females can get the benefits and become less prone to anemia. Still more such plans are required to save the females of North Bengal with poor economic status. Proper steps should be adopted by government and non-government sectors to challenge such under nutrition related health disorder to protect the future generation as well as to restore their physical activity so that they can maintain their earning system through physical activities.

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### REFERENCES

- Agha F, Sadaruddin A, Khan RA, Ghafoor A 1992. Iron deficiency in adolescents. *J Pak Med Assoc*, 42: 3-5.
- Allen LH 2000. Anemia and iron deficiency: Effects on pregnancy outcome. *Am J Clin Nutr*, 71: 1280S-1284S.
- Baig-Ansari N, Badruddin SH, Karmaliani R, Harris H, Jehan I, Pasha O, Moss N, McClure EM, Goldenberg RL 2008. Anemia prevalence and risk factors in pregnant women in an urban area of Pakistan. *Food Nutr Bull*, 29: 132-139.
- Balducci L 2003. Epidemiology of anemia in the elderly: Information on diagnostic evaluation. *J Am Geriatr Soc*, 51: S2-S9.
- Bodnar LM, Scanlon KS, Freedman DS, Siega-Rig AM, Cogawell ME 2001. High prevalence of postpartum anemia among low income women in the United States. *Gynecol*, 185: 438-443.
- Bulliy G, Mallick G, Sethy GS, Kar SK 2007. Hemoglobin status in non-school going adolescent girls in three districts of Orissa, India. *Int J Adolesc Med Health*, 9: 395-406.
- Chakma T, Rao PV, Tiwari RS 2000. Prevalence of anaemia and worm infestation in tribal areas of Madhya Pradesh. *Ind J Med Assoc*, 98: 570-571.
- Charoenlarp P, Dhanamitta S, Kaewvichit R, Silprasert A, Suwanaradd C, Nanakorn S et al. 1988. A WHO collaborative study on iron supplementation in Burma and in Thailand. *Am J Clin Nutr*, 47: 280-297.
- Choi CW, Lee J, Park KH, Yoon SY, Choi IK, Oh SC, Seo JH, Kim BS, Shin SW 2004. Prevalence and characteristics of anemia in the elderly: Cross-sectional study of three urban Korean population samples. *Am J Haematol*, 77: 26-30.
- Das DK, Biswas R 2005. Nutritional status of adolescent girls in a rural area of North 24 Parganas district, West Bengal. *Ind J Public Health*, 49: 18-21.
- Dharmarajan TS, Avula S, Norkus EP 2006. Anemia increases risks for falls in hospitalized older adults: An evaluation of falls in 362 hospitalized, ambulatory, long term care, and community patients. *J Am Med Dir Assoc*, 7: 287-293.
- Gabrilove J 2005. Anemia and the elderly: Clinical considerations. *Best Pract Res Clin Haematol*, 18: 417-422.
- Gawarika R, Gawarika S, Mishra AK 2006. Prevalence of anaemia in adolescent girls belonging to different economic group. *Ind J Commu Med*, 3: 287-288.
- Goel S, Gupta BP 2007. Low anemia prevalence among adolescents of an urban hilly community. *Ind J Commu Med*, 32: 76-78.
- Hawdon JM, Hotez PJ 1996. Hookworm: Development biology of the infectious process. *Curr Opin Genet Dev*, 6: 618-623.
- Izaks GJ, Westendorp RG, Knook DL 1999. The definition of anemia in older persons. *J Am Med Assoc*, 281: 1714-1717.
- Jinabhai CC, Taylor M, Coutsooudis A, Coovadia HM, Tomkins AM, Sullivan KR 2001. A health and nutritional profile of rural school children in KwaZulu-Natal, South Africa. *Ann Trop Paediatr*, 21: 50-58.
- Landi F, Russo A, Danese P, Liperoti R, Barillaro C, Bernabei R, Onder G 2007. Anemia status, haemoglobin concentration and mortality in nursing home older residents. *J Am Med Dir Assoc*, 8: 322-327.
- Li R 1993. *Functional Consequences of Iron Deficiency in Chinese Female Workers*. PhD Thesis, Unpublished. Wageningen: University of Wageningen.
- Lohman TG, Roche AF, Martorell R 1988. *Anthropometric Standardization Reference Manual*. Human Kinetics Books: Chicago, II.
- McCormick MC 1985. The contribution of low birth weight to infant mortality and childhood mortality. *N Engl J Med*, 31: 82-90.

- Murthy GL, Sahay RK, Srinivasan VR, Upadhaya AC, Shantaram V, Gayatri K 2000. Clinical profile of falciparum malaria in a tertiary care hospital. *Ind J Med Assoc*, 98: 160-162.
- National Family Health Survey-India (2005-2006) 2008. Bombay: International Institute of Population Studies.
- Nissenson AR, Goodnough LT, Dubois RW 2003. Anemia, not just an innocent bystander? *Arch Intern Med*, 163: 1400-1404.
- Pandit D, Prabha R, Shanbhag S, Mayekar R 2005. Morbidity pattern of women attending screening program in an urban slum in Mumbai. *Ind J Commu Med*, 30: 134-135.
- Prakash N, Banerjee HN 1972. Evaluation of cyanmethaemoglobin method for hemoglobin estimation. *Ind J Chest Diseases*, 14: 102-105.
- Rajagopalan S 2003. Towards Malnutrition Free Tamil Nadu: 30th Annual Session of United Nations Standing Committee on Nutrition, *Task Force Report*, Chennai.
- Rajaratnam J, Abel R, Asokan JS, Jonathan P 2000. Prevalence of anemia among adolescent of rural Tamil Nadu. *Ind Pediatr*, 37: 532-536.
- Scholl TO, Hediger ML, Fischer RL, Shearer JW 1992. Anemia vs iron deficiency: Increased risk of pre-term delivery in a prospective study. *Am J Clin Nutr*, 55: 985-988.
- Shah BK, Gupta P 2002. Anemia in adolescent girls: A preliminary report from semi-urban Nepal. *Ind Pediatr*, 39: 1126-1130.
- Singh N, Shukla MN, Sharma VP 1999. Epidemiology of malaria in pregnancy in central India girls. *Bull World Health Organ*, 77: 567-572.
- Steer PJ 2000 Maternal hemoglobin concentration and birth weight. *Am J Clin Nutr*, 71: 1285S-1287S.
- Vasanthi G, Pawashe AB, Susie H, Sujatha T, Raman L 1994. Iron nutritional status of adolescent girls from rural area and urban slums. *Ind Pediatr*, 31: 127-132.
- Verhoeff FH, Brabin BJ, Chimsuku L, Kazembe P, Russell WB, Broadhead RL 1998. An evaluation of the effects of intermittent sulfadoxine-pyrimethamine treatment in pregnancy on parasite clearance and risk of low birth weight in rural Malawi. *Ann Trop Med Parasitol*, 92: 141-150.
- World Health Organization 1992. *The Prevalence of Anemia in Women: A Tabulation of Available Information*. Geneva: World Health Organization.