Original Research

Prevalence of anaemia and its determinants among non-pregnant rural women aged 19-30 years in Coimbatore, India

Jenit Osborn[1], Nidhya Ganesan[1], Seetha Panicker[1], M Sivamani[1*], V Ramamurthy[2]

[1]PSG Institute of Medical Sciences and Research, Coimbatore, India; [2]PSG College of Technology, Coimbatore, India

*Correspondence: sivamani_md@yahoo.co.in https://orcid.org/0000-0001-5216-9180

DOI: https://doi.org/10.4038/jccpsl.v28i3.8532

Received on 2 May 2022
Accepted on 8 Aug 2022

Abstract

Introduction: Anaemia is a major public health problem leading to multiple consequences including increased economic burden on the affected individuals, their families, communities and societies. According to the National Family Health Survey (NFHS-4), prevalence of anaemia among reproductive age women is 55% in India. Identifying local determinants, will help to plan for appropriate ways to reduce the risks of morbidity associated with anaemia.

Objectives: To find out the prevalence of anaemia and factors influencing it among non-pregnant women (19-30 years) in a rural area near Coimbatore, India

Methods: The study was conducted in the field practice area of Rural Health Training Centre (RHTC), PSGIMSR, Coimbatore during the period of October-December 2019. Two villages were chosen randomly from the 14 villages and women aged 19-30 years were recruited for the study. A semi-structured questionnaire was used to collect the data pertaining to factors intended for this study. Haemoglobin level was measured using haemoglobin photometer and the determinants were identified using multiple logistic regression analysis.

Results: The current study showed the prevalence of anaemia to be 56.8% (95% CI=50.0, 63.0%). The best determinants of anaemia were found to be low economic status (adjusted odds ratio (aOR)=2.14; 95% CI=1.02, 4.49), less intake of green leafy vegetables (aOR=1.93; 95% CI=1.12, 3.32) and inadequate awareness regarding anaemia. (aOR=1.99; 95% CI=1.09, 3.62).

Conclusions & Recommendations: Anaemia continues to be a public health problem in rural Coimbatore. Along with Weekly Iron and Folic acid supplementation (WIFS), determinants of anaemia have to be addressed among reproductive age women.

Keywords: *anaemia, prevalence, haemoglobin photometer, risk factors*

Introduction

Anaemia is a major public health problem affecting almost a quarter of the global population (1). The most vulnerable groups affected by anaemia are children, adolescent girls and women in the reproductive age and especially pregnant women. It poses a significant morbidity risk, particularly among reproductive age women (2). Anaemia can reduce the quality of life leading to a substantial economic burden on the affected individuals and their families, communities and societies (3).

According to the Fourth National Family Health Survey (NFHS-4), 54.4% and 56.9% of the women of reproductive age are found to be anaemic in rural areas of India and in Tamilnadu, respectively (4). Anaemia is found to be more prevalent among reproductive age women in India and this nutritional handicap in the life of women will have adverse consequences on the developmental stages of the next generation and can have long term impact and thus leave a perpetual effect (5). Anaemia is considered as a silent killer due to its major consequences on human health as well as on the social & economic development of a country (6). Conceptual framework for anaemia explains the influence of socio-economic factors on the underlying causes of anaemia like inadequate access to nutrients, mother and childcare, spacing, and food & water sanitation. Considering these factors, the WHO recommends local studies for each region to provide baseline information for designing prophylactic and therapeutic strategies for control of this problem (1). Even though many studies have been done on anaemia in India, social, cultural, economic, and dietary features vary widely across the country. Identifying local determinants and planning for appropriate strategies for the prevention and control of anaemia are some of the priorities of the safe motherhood initiative.

Coimbatore is a highly industrialised district in Tamilnadu with majority of women in the district having more than 12 years of schooling, one third gainfully employed and total fertility rate is 1.7. Still anaemia is highly prevalent (4). Rapid urbanization has influenced the lifestyle of rural Coimbatore also. On the basis of these facts, this study was carried to find out the prevalence of anaemia among women aged 19-30 years and its association with selected risk factors among non-pregnant reproductive age women in the rural field practice area in Coimbatore District.

Methods

A community-based cross-sectional study was done in the rural field practice area of PSG Institute of Medical Sciences and Research (PSGIMS&R), Coimbatore during the period of October-December 2019. The RHTC caters to a population of 25 886 distributed in 14 villages. The sample size was calculated using the prevalence estimate formula (7) with an estimated anaemia prevalence of 55% as per the NFHS-4 study (4), allowable error of 15%, design effect of 1.5 and non-response rate of 20%, which was estimated as 218. The Institutional Human Ethics Committee (IHEC) approval was obtained. Two villages were chosen randomly out of the 14 villages in the field practice area of Rural Health Training Centre attached to the Department of Community Medicine. Women aged 19-30 years were chosen for the study, since data from the service area of RHTC have shown that most of the reproductive age women complete their family before they complete 30 years. Women in reproductive age group (19-30 years) who are permanent residents for at least one year in the field practice area of RHTC (Vedapatti) were enumerated by a door-to-door survey in the two villages and universal sampling method was followed to enrol all the eligible participants. Pregnant women, lactating women and women who were not present at home on three visits were excluded from the study.

After getting informed consent, a semi-structured questionnaire was designed and used to collect data pertaining to the factors influencing the prevalence of anaemia, namely demographic factors, socio-economic, environmental factors, reproductive factors, menstrual factors and dietary pattern using a food frequency questionnaire. Knowledge regarding causes of anaemia, symptoms of anaemia, and measures for prevention of anaemia and about iron rich foods was assessed using a 12-point scoring

questionnaire. For every correct answer, they were given a score of one and those who scored >6 points were considered as having adequate knowledge regarding anaemia.

Height and weight were measured in all participants according to WHO standard procedure (8). Further, in a sub-sample (50%) of anaemic patients, their haematologic health was assessed with complete hemogram, peripheral smear, serum iron and serum ferritin. Haemoglobin level was measured using haemoglobin photometer which is a reliable method for determining haemoglobin concentrations in field surveys (9-11). The sensitivity and specificity for the haemoglobin estimation by haemoglobin photometer is 94.1% and 95.2%, respectively (12). The WHO criteria for diagnosis of anaemia in non-pregnant non lactating women - haemoglobin level less than 12 g/dl was used for the purpose of classification (8). Further, grading of anaemia was done as 'mildly anaemic' (11-11.9 g/dl), 'moderately anaemic' (8-10.9 g/dl) and 'severely anaemic' (<8 g/dl).

Data analysis

Data entry was done in the Microsoft Excel software in codes and the analysis with Statistical Package for Social Sciences (SPSS) version 24. Categorical variables were expressed as percentages, whereas continuous variables were expressed using mean and standard deviation (SD). The associations between independent variables and haemoglobin level were tested for significance using Chi-squared test and strength of association was estimated using the odds ratio (OR). The variables which were found to be statistically significant by univariate analysis were further subjected to multivariate logistic regression analysis. P value <0.05 was considered as statistically significant.

Results

To assess the prevalence of anaemia among women in rural households, a random sample of two villages were chosen. The total number of line-listed 19–30-year-old women was 254. Out of them, seven were pregnant and three were already on treatment for anaemia and they were excluded from the study. Six women were not present at home during any of the three visits for recruitment and nine women were not willing to participate; the remaining 229 consented and were enrolled. The demographic profile of study participants is shown in Table 1. Among the sample studied, 52% were aged 19-24 years; 48% were college graduates; 34.1% were employed with a salary; 65.1% belonged to nuclear family than joint family; and 39.7% were married.

Prevalence of anaemia

The mean haemoglobin content of the study participants was 11.42 (SD=1.99) g/dl. The mean (SD) haemoglobin level among participants classified as anaemic and not anaemic was 10.04 (1.85) g/dl and 13.16 (0.85) g/dl, respectively. The prevalence of anaemia among the study population was 56.8 % (95% CI=50.2, 62.9%). Out of the 130 anaemic women, 42.3% of them were mildly anaemic, 46.9% were moderately anaemic and 10.7% were severely anaemic.

In the sub-sample (50%) of anaemic participants, the mean (SD) serum iron and serum ferritin levels were 52.10 (41.98) µg/dl and 24.71 (33.28) ng/ml, respectively. The peripheral smear analyses of the patients confirmed that the common type of anaemia was microcytic hypochromic anaemia (69.69%) followed by normocytic hypochromic anaemia (22.72%) and normocytic normochromic anaemia (7.57%).

Factors associated with the prevalence of anaemia

Table 2 shows the univariate analysis and logistic regression of the factors associated with anaemia. Among the various factors, after adjusting confounding variables, women from lower socio-economic status (Classes IV & V), having inadequate knowledge regarding anaemia and consume less green leafy vegetables (<2 times weekly) were more prone to suffer from anaemia. None of the participants were acknowledged to be recipients of WIFS under Intensified National Iron Plus Initiative (I-NIPI) Program of Ministry of Health and Family Welfare.

Table 1: Demographic profile of the study participants (N=229)

Parameter	Category	No.	%
Age (in years)	19-24 years	119	52.0
	>24 years	110	48.0
Educational status	Illiterate	4	1.7
	Primary	7	3.1
	Middle	21	9.2
	High school	40	17.5
	Higher secondary	47	20.5
	Graduate	110	48.0
Socio-economic status	Class I	10	4.4
(Modified Prasad Classification)	Class II	88	38.4
	Class III	94	41.0
	Class IV	35	15.3
	Class V	2	0.9
Employment status	Employed	78	34.1
	Not employed	151	65.9
Family type	Nuclear	149	65.1
	Extended	80	34.9
Marital status	Married	91	39.7
	Others	138	60.3

Discussion

Anaemia has been recognized as a public health problem for many years, but only little progress has been made in its control. India was the first developing country to take up a National Anaemia Prophylaxis Programme (NAPP) in 1970, providing iron & folic acid supplementation to all pregnant women and children with an aim to reduce the prevalence of anaemia to below 25% (13). The WHO and UNICEF re-emphasize the urgent need to combat anaemia and stress the importance of recognizing its multifactorial aetiology for developing effective control programmes (8). The current study was an attempt to assess the prevalence of anaemia and the possible associated factors among reproductive age group women in rural Coimbatore.

Among the 244 eligible candidates, 15 were not accessible and thus the non-response rate was 6.14%.

The prevalence of anaemia in the current study was nearly 57% (95% CI=50, 63%) which is 2% higher than that reported in the NFHS-4 study (4) reported in the year 2015-16 suggesting no significant progress during this period. A study by Rao et al. (2011) among rural women of child bearing age (15-35 years) in Pune has reported the prevalence of anaemia as 77% (14), which is much higher than that of the current study, whereas in the study by Bently et al. (2003) among married women aged 15-49 years in Andhra Pradesh, it was 49.5% (15). The WHO considers the prevalence greater than 40% as a problem of high magnitude (2), hence anaemia is a major public health problem among the study population.

In our study, among the 130 anaemic women, majority of them were mild to moderately anaemic and only a few of them were severely anaemic. This finding is consistent with other studies (16-17). Prevention of anaemia in women of reproductive age

Table 2: Association of anaemia with selected risk factors

Variable		Anaemic (n=130) No. (%)	Not anaemic (n=99) No. (%)	OR (95% CI)	aOR (95% CI)	P value
Age	19-24 years	65 (54.6)	54 (45.4)	0.83 (0.49, 1.47)	-	
	24-30 years	65 (59.1)	45 (40.9)			
Educational status	Up to High School	42 (58.3)	30 (41.7)	1.09 (0.62, 1.92)	-	
	Post High school	88 (56.1)	69 (43.9)			
Socio-economic status	Class IV-V	27 (72.9)	10 (27.0)	2.28 (1.04, 4.97)	2.14 (1.02, 4.49)	**0.03**
	Class I-III	103 (53.7)	89 (46.4)			
Employment status	Employed	49 (62.8)	29 (37.2)	1.46 (0.83, 2.55)	-	
	Not employed	81 (53.6)	70 (46.4)			
Family type	Nuclear	80 (53.7)	69 (46.3)	0.69 (0.39, 1.21)	-	
	Joint	50 (62.5)	30 (37.5)			
Marital status	Married	50 (54.9)	41 (55.1)	0.88 (0.51, 1.5)	-	
	Others	80 (57.9)	58 (52.0)			
Body mass index	<18.5 kg/m^2	27 (65.9)	14 (44.2)	1.59 (0.78, 3.21)	-	
	≥18.5 kg/m^2	103 (54.8)	85 (45.2)			
IUCD usage	Yes	13 (59.1)	9 (40.9)	1.22 (0.5, 2.99)	-	
	No	112 (54.1)	95 (45.9)			
Regularity of menstrual cycle	Irregular	13 (68.4)	6 (31.6)	1.72 (0.63, 4.7)	-	
	Regular	117 (55.7)	93 (44.3)			
Menstrual bleed	Excessive	19 (61.3)	12 (38.7)	1.24 (0.57, 2.69)	-	
	Normal	111 (56.1)	87 (43.9)			
Toilet facility	Absent	39 (61.9)	24 (28.1)	1.33 (0.74, 2.42)	-	
	Present	91 (54.8)	75 (45.2)			
Usage of footwear while going out of home	Occasional	15 (65.2)	8 (34.8)	1.48 (0.6, 3.6)	-	
	Mostly	115 (55.8)	91 (44.2)			
Passage of worms in stools	Yes	4 (80.0)	1 (20.0)	3.11 (0.34, 7.28)	-	
	No	126 (56.2)	98 (43.8)			
Usage of soap after defecation	No	16 (59.3)	11 (40.7)	1.12 (0.49, 2.54)	-	
	Yes	114 (56.4)	88 (43.6)			
Type of diet	Vegetarian	20 (62.5)	12 (37.5)	1.31 (0.61, 2.28)	-	
	Mixed	110 (55.8)	87 (44.2)			
Coffee/Tea with food	Yes	19 (59.4)	13 (40.6)	1.13 (0.53, 2.42)	-	
	No	111 (56.3)	86 (43.7)			
Lime juice with food	Yes	13 (81.2)	3 (18.8)	3.56 (0.98, 12.8)	-	
	No	117 (54.9)	96 (45.1)			

Green leafy vegetables	≤ 2 days / week	79 (63.7)	45 (36.3)	1.85 (1.09, 3.15)	1.93 (1.12, 3.32)	**0.017**
	> 2 days / week	51 (48.6)	54 (51.4)			
Fruits	≤ 2 days / week	63 (59.4)	43 (40.6)	1.22 (0.72, 2.07)	-	
	> 2 days / week	67 (54.4)	56 (45.6)			
Milk	≤ 2 days / week	120 (58.8)	84 (41.2)	2.14 (0.91, 3.81)	-	
	> 2 days / week	10 (40.0)	15 (60.0)			
Meat/poultry	≤ 2 days / week	92 (58.2)	66 (41.8)	1.21 (0.68, 1.21)	-	
	> 2 days / week	38 (53.5)	33 (46.5)			
Awareness about anaemia	Inadequate	49 (68.1)	23 (31.9)	1.99 (1.11, 3.59)	1.99 (1.09, 3.62)	**0.024**
	Adequate	81 (51.6)	76 (48.4)			

is essential for child survival and safe motherhood (18). The nutritional handicap in the life of women will be passed on to the next generation and will have a long term adverse consequence (18). Data from the National Nutrition Monitoring Board (NNMB) Surveys (5) showed that Indian women have a sustained low intake of iron. Low quantity of food intake among Indian girls & women may be due to various reasons like economic, social, lack of empowerment, etc.

The anaemic participants of the current study revealed that the majority of them had less serum iron and serum ferritin. Peripheral smear showed that 92.41% of the population had microcytic hypochromic or normocytic hypochromic anaemia. Other causes of hypochromic anaemia such as thalassemia and sickle cell anaemia were not observed. One person who was having sickle cell trait was referred for further management and was not part of this study. Based on the biochemical and peripheral smear examination, it is evident that most of the anaemic patients are suffering from iron deficiency anaemia in the study population.

The risk of anaemia was found to be significantly higher in women from lower socio-economic groups (Classes IV & V), scoring lower in response to the questionnaire about anaemia related information, and whose consumption of green leafy vegetables was done less frequently (<2 times weekly). Women from lower socio-economic groups had two times at risk of being anaemic compared to other groups. This inverse relationship of socio-economic status with anaemia has been consistently reported in other studies as well (19-21). Poor socio-economic status is known to be associated with a number of factors such as high parity, short birth interval, poor diet both in quantity and quality, lack of awareness regarding health and nutrition, and a high rate of infectious diseases and parasitic infestations (16). Poor people often have limited access to medical attention and preventive measures; hence the prevalence of anaemia and its severity has been seen more in the lower socio-economic communities. Secondly those who had inadequate knowledge on anaemia as assessed by their response to our questionnaire were two times at risk of becoming anaemic which was similar to the findings from other similar studies (22-23). Due to lack of adequate knowledge on food containing iron, their choice of food is likely to be improper leading to nutritional handicap which paved the way to its ill effects (18).

Although the adequacy of intake of iron rich food was ascertained only based upon the frequency of intake i.e., number of days/ week and not on the amount of food intake, it was found that those who are taking green leafy vegetables (GLV) less frequently were at higher risk of becoming anaemic. Similar findings have been reported by others (14, 24-27) which showed that lower consumption of GLV was significantly associated with increased risk of developing anaemia.

The study had few limitations like dietary history was limited to self-reported food frequency, hence the quantum of dietary intake of iron could not be ascertained; confirmation of worm infestation by stool

examination was not possible due to operational difficulty; complete haematological and biochemical investigations were not conducted in all participants due to financial constraints; and cause-effect relationship could not be determined due to its cross-sectional design. Our study reiterates the fact that prevalence of anaemia among reproductive age women remains high in rural India due to various factors like socio-economic status, inadequate dietary intake of iron rich foods, and importantly lower awareness of the problem and the available solutions.

Conclusions & Recommendations

Despite India being the first country to start the anaemia prophylaxis program, the current study highlights that anaemia still remains a public health issue of great magnitude among non-pregnant reproductive age women even after fifty years into the program. Approximately 57% of women in the study area were diagnosed to be anaemic suggesting that the measures to prevent and control anaemia so far have largely been ineffective. Intensive approaches are required to combat anaemia and to prevent short- and long-term adverse consequences of anaemia. For this reason, a lifecycle approach for the control of anaemia in women of reproductive age in developing countries has been emphasised (28). Intensified National Iron Plus Initiative of India tries to implement this approach by providing the WIFS. However, none of the participants in the current study informed that they were taking or receiving WIFS. Low coverage of WIFS among adolescents had already been reported in India (29). Therefore, strategies to combat anaemia should address all of the causal factors like low economic status, lack of adequate knowledge regarding anaemia and less frequent intake of green leafy vegetables, so that programs such as WIFS could reach more people and make an impact on this scourge.

Public Health Implications

- Anaemia still continues to be a major public health problem in non-pregnant rural women aged 19-30 years in India.
- Along with WIFS, other risk factors for anaemia need to be addressed urgently.

Author Declarations

***Competing interests**:* The authors declare that they have no competing interests.

Ethics approval and consent to participate: Ethical clearance was obtained from Institutional Human Ethics Committee (IHEC) PSGIMSR (PSGIMSR IHEC No:18/229). Informed written consent was obtained from the participants.

Funding: The project was funded by Grand Challenges Canada (Project No. R-ST-POC-1707-04669) and Prathista Industries Limited, Secunderabad.

Acknowledgements: Authors thank the management of PSG Institute of Medical Sciences and Research, Funding agency, field staff and participants involved in the study.

***Author contributions**:* JO was involved in designing, project implementation, data collection, analysis and preparing the manuscript; MS in conceptualization, designing, project implementation, data collection, analysis and correcting the draft; SP in conceptualization and designing the study; NGG helped in pathological interpretation; and VR conceptualized the study, designed and acquired funding.

References

1. DeMaeyer E & Adiels-Tegman M. The prevalence of anaemia in the world. *World Health Stat Q* 1985; 38(3): 302-316. Available from: https://apps.who.int/iris/bitstream/handle/10665/249240/WHSQ-1985-38-n3-p302-316-eng-fre.pdf.
2. McLean E, Cogswell M, Egli I, Wojdyla D, De Benoist B. Worldwide prevalence of anaemia, WHO vitamin and mineral nutrition information system, 1993–2005. *Public Health Nutr* 2009; 12(4): 444-454. DOI: https://doi.org/10.1017/S1368980008002401.

3. Kaur K. Anaemia 'a silent killer' among women in India: present scenario. *Eur J Zool Res* 2014; 3(1): 32-36. Available from: https://www.academia.edu/download/41725279/Anaemia_study_report_India.pdf.

4. Andia AM, Zisook S, Heaton RK, Hesselink J, Jernigan T, Kuck J, Moranville J, Braff DL. Gender differences in schizophrenia. *J Nerv Ment Dis* 1995; 183(8): 522-528. DOI: 10.1097/00005053-199508000-00005.

5. Bureau NNM. *Diet and nutritional status of population and prevalence of hypertension among adults in rural areas.* National Institute of Nutrition, Indian Council of Medical Research, 2006.

6. World Health Organization. *WHO Vitamin and Mineral the Nutrition/ Anaemia 2011.* Available from: https://apps.who.int/iris/bitstream/handle/10665/177094/9789241564960_eng.pdf.

7. Lwanga SK & Lemeshow S. *Sample size determination in health studies: a practical manual.* Geneva: World Health Organization, 1991. Available from: https://apps.who.int/iris/handle/10665/40062.

8. WHO. *Physical status: the use of and interpretation of anthropometry.* Report of a WHO Expert Committee. Geneva: World Health Organization, 1995. Available from: https://pubmed.ncbi.nlm.nih.gov/8594834.

9. de Benoist B. *Focusing on anaemia: towards an integrated approach for effective anaemia control.* Joint Statement by the World Health Organization and the United Nations Children's Fund. World Health Organization, 2004. Available from: https://www.who.int/publications/m/item/focusing-on-anaemia-towards-an-integrated-approach-for-effective-anaemia-control.

10. WHO. *Micronutrient deficiencies: iron deficiency anaemia.* Geneva: World health Organization. Available from: https://www.who.int/health-topics/anaemia.

11. Johns W & Lewis SM. Primary health screening by haemoglobinometry in a tropical community. *Bull World Health Organ* 1989; 67(6): 627. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2491310/pdf/bullwho00064-0026.pdf.

12. Akhtar K, Sherwani RK, Rahman K, Hasan J, Shahid M. HemoCue photometer: a better alternative of hemoglobin estimation in blood donors? *Indian J Hematol Blood Transfus* 2008; 24(4): 170-172. DOI: 10.1007/s12288-008-0041-8.

13. Agarwal D, Agarwal K, Roychoudhry SJIP. Targets in national anemia prophylaxis programme for pregnant women. *Indian Pediatr* 1988; 25(4): 319-322. PMID: 3225040.

14. Rao S, Joshi S, Bhide P, Puranik B, Kanade A. Social dimensions related to anaemia among women of childbearing age from rural India. *Public Health Nutr* 2011; 14(2): 365-372. DOI: 10.1017/S1368980010002776.

15. Bentley M & Griffiths P. The burden of anemia among women in India. *Eur J Clin Nutr* 2003; 57(1): 52-60. DOI: 10.1038/sj.ejcn.1601504.

16. Yip R. Forging effective strategies to combat iron deficiency-plenary papers-prevention and control of iron deficiency: policy and strategy issues. *Nutri J* 2002; 132(4): 802S. Available from: https://www.semanticscholar.org/paper/Forging-Effective-Strategies-to-Combat-Iron-and-of-Yip/f3d5d1c77a1ffd49902920109493e61aed3c2c02.

17. Thankachan P, Muthayya S, Walczyk T, Kurpad AV, Hurrell RF. An analysis of the aetiology of anemia and iron deficiency in young women of low socioeconomic status in Bangalore, India. *Food Nutr Bull* 2007; 28(3): 328-336. DOI: 10.1177/156482650702800309.

18. Ladipo OA. Nutrition in pregnancy: mineral and vitamin supplements. *Am J Clin Nutr* 2000; 72(1): 280S-90S. DOI: 10.1093/ajcn/72.1.280S.

19. Balarajan YS, Fawzi WW, Subramanian S. Changing patterns of social inequalities in anaemia among women in India: cross-sectional study using nationally representative data. *BMJ Open* 2013; 3(3): 1-11. DOI: 10.1136/bmjopen-2012-002233.

20. Rajaratnam J, Abel R, Ganesan C, Jayaseelan SA. Maternal anaemia: a persistent problem in rural Tamil Nadu. *Nat Med J India* 2000; 13(5): 242-245. Available from: http://archive.nmji.in/archives/Volume-13/issue-5/original-articles-3.pdf.

21. Venkatachalam J, Muthu R, Singh Z, Madhanraj K, Sathya G. Determinants of anemia among women in the age group of 11-49: a case control study in a rural area of Kancheepuram district, Tamil Nadu. *Excel Int J Multidiscip Manag Stud* 2014; 4(2): 218-223. Available from: https://www.researchgate.net/publication/260064345.

22. Ahmad N, Kalakoti P, Bano R, Aarif S. The prevalence of anaemia and associated factors in pregnant women in a rural Indian community. *Hindu* 2010; 208: 67.1. Available from: https://core.ac.uk/download/pdf/26952622.pdf.

23. Mamta K, Vibha B. Anaemia: impact assessment of dietary intervention on iron status of college going girls. *Food Sci Res J* 2011; 2(1): 76-79. Available from: https://www.researchgate.net/publication/236142940.

24. Tadesse SE, Seid O, G/Mariam Y, Fekadu A, Wasihun Y, Endris K, et al. Determinants of anemia among pregnant mothers attending antenatal care in Dessie town health facilities, northern central Ethiopia, unmatched case-control study. *PLoS One* 2017; 12(3): e0173173. DOI: 10.1371/journal.pone.0173173.

25. Karaoglu L, Pehlivan E, Egri M, Deprem C, Gunes G, Genc MF, et al. The prevalence of nutritional anemia in pregnancy in an east Anatolian province, Turkey. *BMC Public Health.* 2010; 10(1): 1-12. DOI: https://doi.org/10.1186/1471-2458-10-329.

26. Obse N, Mossie A, Gobena T. Magnitude of anemia and associated risk factors among pregnant women attending antenatal care in Shalla Woreda, West Arsi Zone, Oromia Region, Ethiopia. *Ethiop J Health Sci* 2013; 23(2): 165-173. Available From: https://www.ajol.info/index.php/ejhs/article/view/91185/80659.

27. Semba RD & Bloem M. The anemia of vitamin A deficiency: epidemiology and pathogenesis. *Eur J Clin Nutr* 2002; 56(4): 271-281. DOI: https://doi.org/10.1038/sj.ejcn.1601320.

28. Gupta A, Kumar R, Mohan A, Rahi S. *Guidelines for Control of Iron Deficiency Anaemia.* New Delhi: Ministry of Health and Family Welfare, Government of India, 2013. Available from: https://www.nhp.gov.in/national-iron-plus-initiative-for-anemia-control_pg.

29. Sudfeld CR, Rai RK, Barik A, Valadez JJ, Fawzi WW. Population-level effective coverage of adolescent weekly iron and folic acid supplementation is low in rural West Bengal, India. *Public Health Nutr* 2020 :1-5. DOI: https://doi.org/10.1017/S1368980020000932.