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Prevalence and Correlates of Nutritional Anaemia among Adolescent Girls of Distt. U.S. Nagar, Uttarakhand

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Authors' contributions

This work was carried out in collaboration between both authors. Author DJ performed the field work, statistical analysis, and wrote the first draft of the manuscript. Author AK designed the study, managed the analyses of the study and finalized the draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: Present study was carried out to determine the prevalence and epidemiological correlates of anaemia among adolescent girls (AGs) of district U. S. Nagar, Uttarakhand (India).

Methodology: A cross sectional study was conducted between March-November 2017 among 880 AGs (10-19 years) in 88 *anganwadi* (AWC) centers covering three blocks one each from rural, urban and tribal blocks of district U.S. Nagar. A pre-structured questionnaire was used to collect socio-demographic, dietary and menstrual health data on AGs along with their anthropometric and heamoglobin (Hb) measurements. Univariate logistic regression analysis was performed using R software between independent variables categorised under socio-demographic characteristics, anthropometric, menstrual health and dietary characters versus the presence of anaemia. Independent variables which were found to be significantly associated with the presence of anaemia, in univariate analysis were further analysed through multiple regression analysis to find predictors of anaemia.

Results: The mean age of the study population was 15.4 years. Prevalence of anaemia was found to be 83.18% among AGs with mean Hb value of 10.62±1.5g/dl. In univariate analysis, consumption of iron folic acid supplement (IFA), age, current school status, exposure to nutrition education on anaemia, mother's literacy status, number of children in the family, abdominal obesity, behavior of skipping meals, number of meals per day, duration of menstrual flow and type of menstrual flow were significantly associated with anaemia in AGs. While multiple regression

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analysis revealed that the strongest predictors of anaemia were non-exposure to nutrition education on anaemia AOR (95%CI) 1.76 (1.36, 3.12); mother's illiteracy AOR (95%CI) 1.56(1.17,1.96) and long duration (>5 days) of menstrual flow AOR (95%CI) 1.45(1.25, 1.65), and these were significantly associated with increased odds of nutritional anaemia while consumption of IFA AOR(95%CI) 0.329(-0.04-0.71), scanty menstrual flow AOR (95%CI) 0.692(-0.45,0.95) and late adolescent age AOR (95%CI) 0.45(-0.03,0.94) showed a protective effect.

Keywords: Nutritional anaemia; adolescent girls; nutrition education; IFA; meal pattern; menstrual flow.

1. INTRODUCTION

Adolescence is a bridge between childhood and adulthood. World Health Organization defined adolescence as the period of life between 10-19 years of age. India is a home to 253 million adolescents, out of which, one-third of boys and half of the girls are anaemic [1]. Adolescence is characterised by second growth spurt where maximum physical, psychological, and behavioural changes take place next to infancy. Nutritional needs are heightened during adolescence on account of rapid growth, weight gain, and blood volume expansion and in case of girls demand of nutrients is additional because of the onset of menstruation. Low intake and poor absorption of iron and increased iron requirements for growth along with replacement of blood losses in menstruation are the causes associated with anaemia in girls [2]. Girls are prone to be a sufferer due to a range of reasons also. In developing countries like India, a multitude of social beliefs and customs stacked against women; malnutrition is quite prevalent among girls. Female child is generally neglected in a household with limited resources. Girl child is given less priority in the household distribution of food and education. On the other hand, she is exploited as an additional working hand for doing household work. Heavy blood flow during menstruation is an extra burden which triggers the crisis too often. So, adolescence is a vulnerable period in the girl's life cycle for the development of nutritional anaemia. Socioeconomic status, combined effect of inadequate nutrition and frequent illness, hand hygiene, worm infestation and infections are the major risk factors leading to anaemia. Socio-demographic factors like low family income, low maternal level of education, lack of access to healthcare services, inadequate sanitary conditions, menstrual health related factors etc. are compelling risk factors for anaemia [3].

Anaemia can adversely affect adolescent girl's learning ability, immunity, productivity and well-being and if not controlled, may result in low birth weight babies, prenatal mortality, increased maternal mortality rate, subsequent high infertility rates and survival, growth and development of children born to them in later life [4,5,6]. So, targeting AGs for reduction and control of anaemia before child bearing can help in controlling its adverse effect during subsequent stages of life [4,6]. Adolescent age in girls is, therefore, a window of opportunity to correct their nutritional status.

Epidemiology of anaemia varies with different socioeconomic, economical and other influencing factors prevailing in different regions. It is important to understand the epidemiology in order to plan effective interventions. It will also be helpful in drawing recommendations and rendering suggestions to evaluate and enhance the existing Anaemia Control Programmes. There is a lack of up-to-date information on prevalence and correlates of anaemia in district U.S. Nagar. This study was undertaken with following objectives:

- To determine the prevalence of anaemia among AGs in the district
- To determine the epidemiological correlates of nutritional anaemia among AGs living in different forward and backward developmental blocks of district U.S. Nagar, Uttarakhand.

2. MATERIALS AND METHODS

2.1 Study Design

A cross sectional study was conducted between March-November 2017 in three developmental blocks namely Rudrapur rural, Rudrapur urban and Sitarganj tribal (with largest number of AWCs) out of total 10 blocks in district Udham Singh Nagar, Uttarakhand. The developmental block or community development block is a district sub-division for the purpose of planning and development and is often the next level of

the administrative division after the *tehsil*. Administrative planning and developmental work are implemented through village panchayats at block level [7].

2.2 Study Setting

The study was carried out at *anganwadi* centers (AWCs) in the Integrated Child Development Services (ICDS) setting of district U.S.Nagar, Uttarakhand (India). An AWC is a focal point to render basic health care services to community as part of the ICDS program, which is world's largest community based programme. An AWC include children (0-6 years), pregnant and lactating mothers, women (15-44 years) and AGs upto the age of 18 as its beneficiaries [8]. Each AWC is located within an easy and convenient reach of the community and covers population of approximately 1000 in rural and urban areas and 700 in tribal areas. So, AGs registered in all AWCs of the district represent approximately the total study population of AGs in district U.S. Nagar, Uttarakhand.

2.3 Ethical Considerations

Ethical approval for the present study was taken from the University Ethics Committee for Human Research (UECHR), G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. In addition informed written consent was taken from each subject and their parents/guardian. Subjects were ensured that the information collected from them will be kept confidential and will be used only for research purpose.

2.4 Sampling Design

2.4.1 Population

AGs (10-19 years) living in district U.S.Nagar, Uttarakhand constituted the study population.

2.4.2 Sampling technique

A 2-stage random sampling technique was employed in the study (Fig. 1). In first stage, 10% of total AWCs in three developmental block one each from rural (Rudrapur rural),urban (Rudrapur urban and tribal (Sitarganj) different blocks, comprising a total of 88 AWCs, were selected randomly in proportion to the number of AWCs in each block using simple random (SRS) sampling method for effective coverage. Ten AGs were then selected randomly from sampled AWCs in the second stage by SRS method.

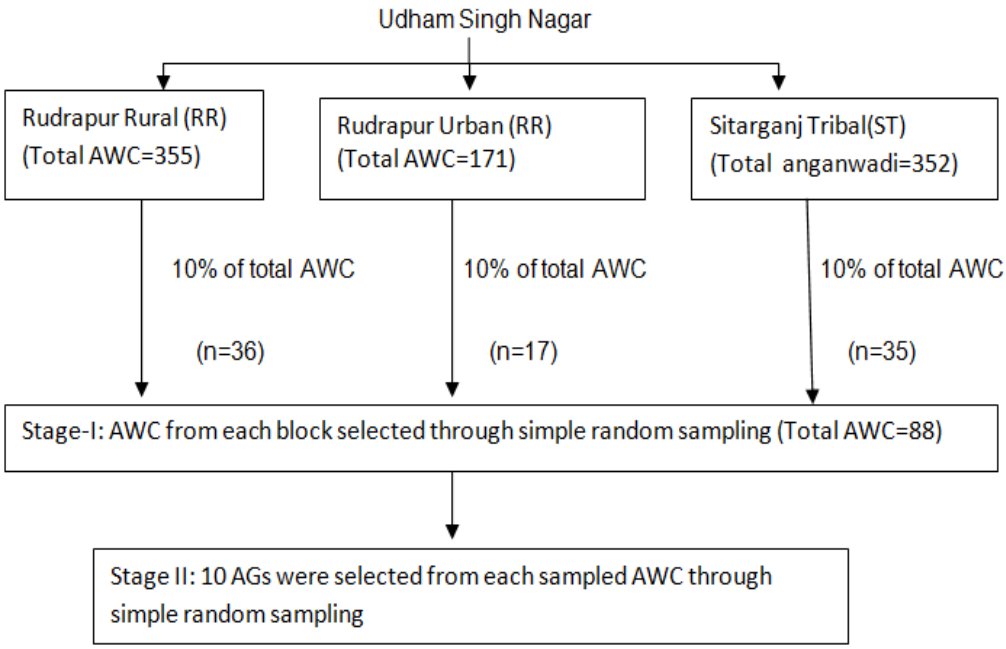

Fig. 1. Schematic representation of sampling design used in the study

2.4.3 Sample size

Considering expected prevalence of anaemia of 50**%** [1,9] in the study population, design effect of 2 [10] and desired level of absolute precision 5%, the total sample size came out to be 810. Therefore 810/88=9.20~10 AGs (10-19 years) selected randomly per AWC, were included in the study [11].

$$sample\ size = (1.96)^2 \times p_{exp} \times \left(1 - p_{exp}\right)(DEFF)/(d)^2$$

Where p_{exp}= expected prevalence of disease; DEFF= design effect; d= absolute precision

2.4.4 Selection criteria

Inclusion criteria: AGs (10-19 years), who were unmarried, were included in the study. AGs who were taking iron and folic acid supplements were not excluded from the sample.

Exclusion criteria: AGs who were below and above the selected age range and those who were married or pregnant at the time of study were not included in the sample.

2.5 Data Collection

Pre-structured and pre-tested questionnaire was used to collect information on general characteristics, socio-demographic characteristics like educational qualification of AG and her parents, family size, family type, standard of living (SLI) index using NFHS-2 method [12], socio-economic status using B.G. Prasad socio-economic classification [13], menstrual pattern (duration of menstrual flow, type of menstrual flow) and dietary pattern (number of meals, behavior of skipping meals). The questionnaire was also validated for reliability through a pilot sample of 10 AGs at AWCs not included in the study area. Hb estimation of all adolescent girl subjects was done using finger prick method followed by estimation of Hb on a Mission Hb meter (Model no L7113P) with a measurement range of 4.5-25.6 g/dl. Ten µL capillary blood was taken from finger tip using a sterilised lancet and immediately transferred to the strip using a capillary tube and read on the instrument. The instrument utilised reflectance photometry method for Hb estimation and is based on the principle of conversion of Hb to cyanmethemoglobin by the addition of drabkin's solution (a solution of potassium ferricyanide and potassium cyanide). The stable color pigment i.e. cyanmethemoglobin was read photometrically at a wave length of 540nm [14]. AGs who had Hb concentration less than 12g/dl were considered as anaemic, whereas girls who had Hb concentration of 11-11.9g/dl, 8-10.9g/dl and <8g/dl were considered as mildly, moderately and severely anaemic [15].

Adolescent girl's weight was measured in kilogram using a standardised weighing machine. Height of the subjects was measured in centimeters (cm) using a vertical measuring rod (anthropometer) having a least count of 0.1cm. Gender-specific BMI-for-age percentile curves developed by WHO were used to define overweight and obesity. Adolescents with a BMI between 85th and 95th percentile for age and gender were considered overweight, those with a BMI more than the 95th percentile were considered as obese and adolescents with a BMI greater than the 99th percentile were considered severely obese [16]. Waist of all subjects was measured in centimeters (cm) using a non-stretchable plastic tape. A waist-height ratio (WHtR) of ≥ 0.5 indicated abdominal obesity [17,18].

2.6 Statistical Analysis

Descriptive statistics like mean, frequency, standard deviation and 95% confidence interval (CI) were used while processing data for analysis. Univariate logistic regression analysis was performed using R software between individual independent variable (age, literacy status, school status, educational level, menarche status, BMI, WHtR, exposure to nutrition education on anaemia, mother's literacy status, number of children in the family, abdominal obesity, food habits, behavior of skipping meals, number of meals per day, duration of monthly menstrual periods, menstrual flow, religion, caste, father's literacy status, family type, family size, family's SLI index and socio-economic status) and presence of anaemia. Unadjusted odds ratio (OR) with their 95% CIs were reported for the bivariate analysis. Multiple regression analysis was further performed between all the variables, which were found to be associated with presence of anaemia (P=0.05) in univariate analysis. After dropping the variables that were found non-significant at multivariate regression analysis level, final model was selected considering the statistical significance (P=0.05) of the predictors [19]. The final model was selected on the basis of theoretical and statistical significance of

predictors and the model estimates are presented with the adjusted odds ratios (AOR) and 95% CI.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Anaemia status among AGs

Mean Hb of AGs was 10.62±1.5 g/dl. The prevalence of anaemia was found to be 83.18% (Table 1). Maximum girls (58.74%) were moderately anaemic, followed by mild anaemia (33.88%) and severe anaemia (7.38%).

3.1.2 Socio-demographic correlates of Anaemia among adolescent girls

Age of AGs was found to be an important correlate of anaemia OR (95% CI) 0.56 (0.37, 0.83) (Table 2). Out of 880 AGs, 565 (64.2%) were attending school while 315 (35.8%) were either school drop-outs or never enrolled in a school ever. Current school status was also found to be significantly associated with presence of anaemia (P=.0.04) Literacy status of AGs (97.7%) was higher as compared to their mothers (70.45%) and fathers (80.45%). Literacy status of AGs and their fathers were not found to be associated with presence of anaemia. On the other hand a significant association between mother's literacy status and anaemia in our study (P=.01) reflect better awareness among literate mothers. Mother's illiteracy was associated with increased odds of anaemia OR(95%CI) 1.52(1.03,2.24).

Out of school-going adolescent girls, maximum (30.2%) were educated till upper primary and minimum (4.0%) had non-formal education i.e. attending night/ mobile schools. None of the girl's, mother's and father's educational status was found to be associated with presence of anaemia. Majority of participants were Hindu (66.9%) however only one participant was Christian. Study revealed highest fraction of AGs belonging to other backward castes (OBC), however lowest percentage of study participants belonged to schedule tribes (13.0%). Both religion (P=0.68) and caste (0.22) were not associated with presence of anaemia. Non exposure to nutrition education on anaemia was found as one of the key predictors OR (95%CI) 1.77(1.23, 2.57) of anaemia among study population. Among 880 adolescent girls, 397 were neither exposed to nutrition education, nor were they consumed IFA supplement. Further 144 adolescent girls were exposed to nutrition education only, 230 were only on IFA supplementation and 109 were exposed to nutrition education as. well as were consuming IFA. However consumption of IFA supplement was found to have protective effective. Non-consumption of IFA supplement was found to be associated with increased odds of anaemia OR(95% CI) 3.05 (2.12-4.38). (Adolescent girls were taking one IFA tablet per week, provided to them under WIFS programme. Each IFA tablet contains100mg elemental iron and 500ug folic acid). It was found that the number of children in the family was associated with anaemia in AGs (P=0.02). Study revealed that increase in number of children in the family increased the chances of occurrence of anaemia. Majority of the girls i.e. 92.6% belonged to families with high SLI index. Maximum girls belonged to families in lower middle class (52.5%) followed by middle class (24.5%) (Table 2).

3.1.3 Anthropometric correlates of Anaemia

BMI of participants revealed that maximum girls (71.6%) were normal while only 2.8% were obese. Abdominal obesity, as shown by WHtR ≥0.50, was found among girls 20.45% AGs (Table 3). Present study revealed that WHtR and BMI were not associated with presence of anaemia in AGs.

Table 1. Prevalence and severity of anaemia among AGs

Prevalence of anaemia	Hb(g/dl)*	Number (%)
Non-anaemic	≥ 12	148 (16.82)
Anaemic	<12	732(83.18)
Severity of anaemia	**Hb(g/dl)**	**Number (%)**
Mild	11-11.9	248 (33.88)
Moderate	8-10.9	430 (58.74)
Severe	<8	54 (7.38)

**WHO cut-offs (2011) [15]*

Table 2. Socio-demographic correlates of presence of anaemia among AGs: Univariate logistic regression analysis[#]

Variable	Anaemia (n=732)	Non-anaemic (n=148)	Total (n=880)	OR (95% CI)	*P*-value
Age (years)					
Early adolescents (10-14)	280(88.1)	38(11.95)	318	Reference	0.001*
Late adolescents (15-19)	452(80.4)	110(19.57)	562	0.56 (0.37, 0.83)	
Mean age (Mean±SD)	15.29±2.69	16.06±2.38	15.42±2.66	--	--
School status					
Attending	479(84.8)	86(15.22)	565	Reference	0.04*
Not attending	253(80.3)	62(19.68)	315	0.73(0.51-1.05)	
Literacy status					
Illiterate	15 (75.0)	05(25.00)	20	0.6(0.21-1.67)	0.29
Literate	717(83.4)	143 (16.63)	860	Reference	
Educational level					
Non-formal education	27(77.1)	08(22.86)	35	0.68(0.25-1.81)	0.67
Primary	164(89.6)	19(10.38)	183	1.73(1.59-1.87)	
Upper primary	216(18.2)	50(18.80)	266	0.86(0.44,1.69)	
High school	140(80.0)	35(20.00)	175	0.80(0.40,1.61))	
Intermediate	120(83.9)	23 (16.08)	143	1.04(0.5-2.2)	
Graduation	65(83.3)	13(16.67)	78	Reference	
Religion					
Hindu	491(83.4)	98(16.64)	589	Reference	0.68
Muslim	184(81.1)	43(18.94)	227	0.85(0.57-1.27)	
Sikh	56(88.9)	07(11.11)	63	1.6(0.71,3.6)	
Christian	01(100.0)	00(00.00)	01	-	
Others	0(0.0)	00(00.00)	0		
Caste					
General	204(84.3)	38((15.70)	242	Reference	0.22
Schedule caste	133(85.3)	23(14.74)	156	1.08(0.61-1.89)	
Schedule Tribe	104(91.2)	10(08.77)	114	1.94(0.93-4.04)	
OBC	291(79.1)	77(20.92)	368	0.70(0.46-1.08)	
Exposure to nutrition education NE) on anaemia					
Yes	195(77.1)	58(22.92)	253	Reference	
No	537(85.7)	90(14.35)	627	1.77(1.23,2.57)	0.005*
Consumption of iron and folic acid (IFA) supplement					
Yes	247(73.29)	90(26.71)	337	Reference	1.11e-
No	485(89.32)	58(10.68)	543	3.05 (2.12-4.38)	08*
Father's literacy status					
Illiterate	145(84.3)	27(15.70)	172	1.11(0.7-1.74)	0.83
Literate	587(82.9)	121(17.09)	708	Reference	
Mother's literacy status					
Illiterate	221 (85.0)	39(15.0)	260	1.52(1.03,2.24)	0.01*
Literate	489(78.9)	131(21.01)	620	Reference	
Family type					
Nuclear	573(83.3)	115(16.72)	688	Reference	0.56
Joint	43(86.0)	07(14.00)	50	1.23(0.54,2.81)	
Extended	116(81.7)	26(18.31)	142	0.9(0.56,1.43)	
Family size					
Small (1-4)	103(84.4)	19(15.57)	122	Reference	0.96
Medium (5-8)	514(82.6)	108(17.36)	622	0.88(0.52,1.49)	
Large (>8)	115 (84.6)	21(15.44)	136	1.01(0.51,1.98)	

Variable	Anaemia (n=732)	Non-anaemic (n=148)	Total (n=880)	OR (95% CI)	*P*-value
Number of children in the family					
1-2	81(79.4)	21(20.6)	102	Reference	0.02*
3-4	344(80.7)	82(19.3)	426	1.09(0.64-1.86)	
5-6	219(83.9)	42(16.1)	261	1.35(0.75,2.42)	
>6	82(90.1))	09(09.9)	91	2.36(1.02-5.47)	
SLI					
Low (0-14)	02(100.0)	00(00.00)	02	-	0.97
Medium (15-24)	51(80.9)	12(19.05)	63	0.85(0.44-1.64)	
High (25-67)	679(83.3)	136(16.69)	815	Reference	
Socio-economic status					
Upper class (I)	7(100.0)	00(00.00)	07	-	0.48
Upper-middle class (II)	59(83.1)	12(16.90)	71	Reference	
Middle class (III)	183(84.7)	33(15.28)	216	1.13(0.55-2.32)	
Lower middle class (IV)	382(82.7)	80(17.32)	462	0.97(0.5-1.89)	
Lower class (V)	101(81.4)	23(18.55)	124	0.89(0.41-1.93)	

**significant at P<0.05*

 # figures in parentheses represent percentage

Table 3. Anthropometric correlates of presence of anaemia among AGs: Univariate logistic regression analysis

Variables	Anaemia (n=732)	Non-anaemic (n=148)	Total (n=880)	OR(95% CI)	*P*-value
BMI					
Underweight	155(81.1)	36(18.85)	191	0.81(0.53-1.24)	0.75
Normal	530(84.1)	100(15.87)	630	Reference	
Overweight	26(76.5)	08(23.53)	34	0.61(0.27-1.39)	
Obese	21(84.0)	04(16.00)	25	0.99(0.33-2.95)	
WHtR					
<.50	580(82.86)	120(17.14)	700	Reference	0.462
≥.50	152(84.44))	28(15.56)	180	1.12(0.72-1.76)	

**significant at 95% C.I*

 # figures in parentheses represent percentage

3.1.4 Menstrual health correlates of Anaemia among AGs

Present study revealed that 80.7% (n=710) AGs had attained menarche. Out of 710 AGs, who attained menarche, 582 had irregular menstrual periods. Menarche status and regularity of menstrual periods did not have significant association with anaemia among study population.

It was found that 478 (67.3 %) girls out of 710, had normal menstrual flow, whereas only 76 (10.7 %) had heavy menstrual flow. Maximum girls i.e. 39.4 % had a monthly menstrual period of 3-4 days, while minimum (5.4%) were found to menstruate for less than 3 days a month. Scanty menstrual flow OR (95% CI) 0.72(0.44,1.17) was significantly associated with decreased odds of anaemia whereas duration of>5 days menstrual period OR (95% CI) 6.09(2.52,14.7) had association with increased odds of anaemia. Around 90.3% of AGs with a duration of menstrual period more than 5 days and 84.2 % of AGs with heavy menstrual flow were found to be anaemic (Table 4).

3.1.5 Dietary correlates of anaemia

Maximum AGs (71.93%) were non vegetarian in their food habits, however no girl was found to be vegan. About 61.48% of subjects were taking three meals in a day, while only 8.75% had more than three meals a day. Behavior of skipping meals was common among 68.0% of girls. Variables like number of meals a day (P=04) and behavior of skipping meals (P=.03) were associated with presence of anaemia, but food habit was not found to be associated with presence of anaemia. Further, it was found that majority of the girls were skipping breakfast

(60.37%), followed by lunch (23.74%) and dinner (14.05%). Type of meal skipped was also not found to be associated with presence of anaemia (P=0.749) (Table 5).

Table 4. Menstrual health correlates of presence of anaemia among AGs: Univariate logistic regression analysis

Variables	Anaemic (n=732)	Non-anaemic (n=148)	Total (n=880)	OR(95% CI)	*P*-value
Menarche status					
Attained	586(82.5)	124(17.46)	710	0.78(0.48,1.25)	0.19
Not attained	146(85.9)	24(14.12)	170	Reference	
Duration of menstrual flow (Days)					
<3 days	23(60.5)	15(39.47)	38	Reference	0.003*
3-4 days	232(82.9)	48(17.14)	280	3.7(1.78,7.66)	
4-5 days	199(82.9)	41(17.08)	240	3.17(1.52,6.58)	
>5 days	112(90.3)	12(09.68)	124	6.09(2.52,14.7)	
No response	20(71.4)	08(28.57)	28		
Type of menstrual flow					
Scanty	101(78.9)	27(21.10)	128	0.72(0.44,1.17)	
Normal	401(83.9)	77(16.1)	478	Reference	0.047*
Heavy	64(84.2)	12(15.8)	76	1.02(0.53,1.99)	
No response	20(71.4)	08(28.6)	28		
Regularity of menstrual periods					
Regular	98(80.3)	24(19.7)	122	Reference	0.37
Irregular	484(83.2)	98(16.8)	582	1.21(0.74,1.99)	
No response	04(66.7)	02(33.33)	06		
Total	586	124	710		

** significant at 95% C.I*

 # figures in parentheses represent percentage

Table 5. Dietary correlates of anaemia among AGs: Univariate regression analysis

Variables	Anaemic	Non-anaemic	Total (n=880)	OR(95% CI)	*P*-value
Food habit					
Ova-vegetarian	44(80.0)	11(20.00)	55	0.82(0.41,1.64)	
Vegetarian	163(84.9)	29(15.10)	192	1.16(0.74,1.81)	0.87
Non-vegetarian	525(82.9)	108(17.06)	633	Reference	
Number of meals per day					
Two	204(77.9)	58(22.14)	262	0.92(0.49,1.72)	0.04*
Three	467(86.3)	74(13.68)	541	1.66(0.91,3.02)	
More than three	61(79.2)	16(20.78)	77	Reference	
No response	00(00.00)	00(00.00)	00		
Behavior of skipping meals					
Yes	487(81.4)	111(18.56)	598	0.67(0.45,1)	0.03*
No	242(86.7)	37(13.26)	279	Reference	
No response	3(100.0)	00(00.00)	3		
Type of meal skipped					
Breakfast	280(77.56)	81(22.44)	361	0.63 (0.33-1.2)	0.749
Lunch	126(88.73)	16(11.27)	142	1.44(0.66,3.17)	
Dinner	71(84.52)	13(15.48)	84	Reference	
Other	10(90.9)	01(09.09)	11		

** significant at 95% C.I*

 # figures in parentheses represent percentage

3.1.6 Multivariate logistic regression analysis

Multivariate logistic regression analysis was performed considering in a single model all the individual variables (not independent to each other) that were found associated with anaemia during univariate analysis, in order to find out which variables have a major effect on dependent variable (presence of anaemia) . In multivariate analysis school status, number of children in the family, number of meals in a day and behavior of skipping meals were not found to have significant association with anaemia. Of the variables that remained significantly associated with increased odds of anaemia non exposure to nutrition education on anaemia (95%CI) 1.76 (1.36, 3.12), mother's illiteracy AOR (95%CI) 1.56(1.17, 1.96) and monthly menstrual period of > 5 days AOR (95%CI) 1.45(1.25, 1.65). Whereas scanty menstrual flow AOR (95%CI) 0.692(-0.45,0.95), late adolescence AOR (95%CI) 0.45(-0.03,0.94) and consumption of IFA supplement AOR(95%CI) 0.329(-0.04-0.71), were associated with decreased odds of nutritional anaemia (Table 6).

As consumption of iron and folic acid found to be major predictive variable associated with the decreased odds of anaemia among adolescent girls and other variables seems to be secondary to it, multivariate logistic regression analysis was performed for adolescent girls who were not taking IFA supplements (Table 7). It was found that exposure to nutrition education, mother's illiteracy and scanty menstrual flow were not associated with odds of anaemia, whereas duration of >5 days of menstrual flow AOR (95%CI) 1.31(1.09, 1.53) and late adolescent age AOR (95%CI) 0.33(-0.38,1.03) were associated with increase and decrease odds of anaemia among AGs not consuming IFA supplements. Hence duration of >5 days of menstrual flow and late adolescent age were associated with presence of anaemia independent of IFA consumption.

3.2 Discussion

Present study revealed that 83.18 % of AGs were anaemic. This is consistent with the results (80 %) of the study conducted by Rati and Jawadagi [20]. Whereas Toteja et al. [21] in their study in 16 districts of the country found 90% of the AGs to be anaemic. They also reported higher percentage of moderate anaemia (49.9 %), in comparison to mild (35.5 %) and severe anaemia (8.8 %). Difference in the study area, might be the reason for this variability in the prevalence rate. A higher percentage of girls in early adolescence were found to be anaemic as compared to girls in late adolescence. Consistent results were reported by Ramchandaran et al. in their study among AGs of rural Puducherry. They also revealed that higher proportion of early AGs(65.4%) were anaemic as compared to late AGs (34.6%) [22]. While Biradar et al. [23] reported more anaemia prevalence among girls above 14 years of age in comparison to those below 14 years. Talan [24] in their study among 500 adolescent girls (10-19 years) of Uttar Pradesh, India found higher prevalence of anaemia among early adolescents (65.7%) as compared

Table 6. Multivariate logistic regression analysis: Predictors for presence of anaemia in AGs

Variables/ Predictors	AOR(95% CI)	*P*-value	*Coefficient*	*SEM*
Non-exposure to nutrition education on anaemia	1.76 (1.36, 3,12)	0.006*	0.565	0.205
Mother's illiteracy	1.56(1.17,1.96)	0.026*	0.446	0.201
Duration of >5 days of menstrual flow	1.45(1.25, 1.65)	0.0002*	0.372	0.102
Scanty menstrual flow	0.692(-0.45,0.95)	0.005*	-0.359	0.130
Late adolescent age	0.45(-0.03,0.94)	0.001*	-0.791	0.247
Consumption of iron and folic acid supplement	0.329(-0.04-0.71)	8.1E-09*	-1.11	0.193

** significant at 95% C.I*

Table 7. Multivariate logistic regression analaysis: Predictors of anaemia among AGs with non-consumption of IFA supplement

Variables/ Predictors	AOR(95% CI)	*P*-value	*Coefficient*	*SEM*
Duration of >5 days of menstrual flow	1.31(1.09, 1.53)	0.016*	0.271	0.113
Late adolescent age	0.33(-0.38,1.03)	0.002*	-1.12	0.359

** significant at 95% C.I*

to middle (31.1%) and late adolescents (46.1%). Similarily Shaka and Wondimagegne among 443 adolescent girls of Wonago district, South Ethiopia found higher anaemia among those in early adolescence period { AOR CI 95%, 4.75 (1.69-13.35)} compared to late adolescence [25]. According to them adolescents in early stages of adolescence are more prone to development of anaemia. Bulliyy et al. found 96.5% prevalence among non school going AGs in three districts of Orissa [26]. Whereas in our study, a higher prevalence of anaemia was found among those AGs who were attending school (64.20 %) than those not attending school (35.80 %). The high prevalence among school going girls could be due to the habit of not taking packed lunches to school, which was observed among 53.81% of school going girls in the study.

Parent's literacy and educational status are associated with child's nutritional status as literate and well educated parents are expected to have better awareness of their child nutritional requirements, as well as such parents are more capable of providing better socio-economic status to their child. Similar to present study, Rawat et al. also reported a significantly higher (P<0.01) prevalence of anaemia among participants having illiterate mothers [27]. According to Rekic et al., religion affiliation is also one of the risk factors associated with lower Hb level [28]. Whereas, Poyyamozhi et al. in their study among 373 AGs found that neither the religion nor the caste was found associated with presence of anaemia [29]. Number of children in the family was also found associated with anaemia, as greater the numbers of children in the family greater the demand for foods and poor the quality of care, that implies greater risk of anaemia [30].

Our study revealed no significant association between BMI and anaemia. A similar study was conducted in Srilanka, in which BMI had no significantly associated with presence of anaemia [31]. In another similar kind of study, it was found that odds of anaemia decreased with obesity [32]. The difference in the results may be due to difference in the age, race and geographical area of the study population.

Present study also reported no association with menarche status but a significant association was found between duration of menstrual flow and anaemia. The results were supported by Siva et al. who found in their study among AGs in Kerala that menarche status was not associated with anaemia (0.518), however number of pads used per day during menstruation (indicative of amount of blood loss) was significantly associated with anaemia [33]. Bernardi et al. who studied the association between menstrual bleeding and anaemia among pre-menopausal women, reported a relationship between perceived heaviness of menstrual flow and anaemia (P=0.02) [34]. Heath et al. also reported heavy menstrual blood loss was related with risk of anaemia [35]. Whereas Patle and Kubde, in their study reported no significant association between presence of anaemia and duration of monthly menstrual period.Further [36]. Kaur et al. in their study among AGs of Wardha reported no association between menarche status and anaemia [37]. The association in the present study might be attributed to greater menstrual losses due to long durations of menstrual periods.

Present study revealed behavior of skipping meals to be a risk factor to anaemia as that meal skippers probably eat less that non-meal skippers. Study also reported an association between meal frequency and anaemia. The results are consistent with the study done among pregnant women in Ethiopia. In the study meal frequency less than 2 meals a day[AOR 3.93 95% CI (2.0,7.9)] was found to be a factor affecting anaemia among pregnant women [38].

Non exposure to nutrition education was found to be leading predictor of anaemia This reflects a better awareness among AGs who were exposed to such nutrition education ever .Nutrition education is an effective means in anaemia prevention as it is the most fundamental and permanent way to bring changes in food consumption pattern and to obtain a balanced nutrition [39]. Yusoff et al. suggested that nutritional education increases knowledge, attitudes and hemoglobin levels among adolescents [40]. Garcia-Casal et al. in their study among school students (6-14 years) in Venezuala reported that the nutritional education intervention produced a significant reduction in iron deficiency prevalence (25 to 14%) [41]. Consumption of IFA supplement was found to have protective effect against anaemia. Gopalan too stressed on IFA supplementation among adolescent girls as an impactful strategy to prepare them for the reproductive age group with adequate ion stores. According to him adolescence provides opportunities before marriage and child bearing that should not be

wasted [42]. Divakar et al. in their pilot study among adolescent girls in India, found a positive impact of WIFS programme with a decline in anaemia prevalence [43].

The major strengths of this study are a large evenly covered sample and use of objective method (Hb measurement) for the detection of anaemia, and therefore its findings that stress urgent action on the part of policy makers. However there are some limitations like qualitative information was not collected on the epidemiological correlates, objective methods to evaluate menstrual health were not undertaken to pinpoint causal factors and this could be taken up in future studies.

4. CONCLUSION

A high anaemia prevalence rate (83.18%) in AGs in this area is a public health concern and demands urgent intervention. The significant association of anaemia with consumption of iron and folic acid supplements, age, schooling status, mother's literacy, number of children in the family, nutrition education, meal pattern, menstrual flow stressed the need to develop new and innovative strategies for nutrition education, family planning, improvement in menstrual health and anaemia prophylaxis. Addressing the nutritional anaemia among adolescent girls will require attention to both nutrition education and iron supplementation programs targeting adolescent girls. Community based information, education and communication activities regarding personal hygiene and promotion of healthy nutritional practices should be implemented. As well as nutrition education as a long term strategy to bring desired behavioral changes among adolescents, should be a part of current education system and anaemia prophylaxis programmes.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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