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Prevalence of Anemia Among College Going Adolescent Girls of Ganjam District, Odisha: A Cross-sectional Study

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ABSTRACT: Anaemia is a global health concern affecting adolescents and children in developing countries. The prevalence of anemia among adolescents in the South-East Asian region ranges from 27% to 55%. The significant challenges of anemia include poor cognitive and motor development. Hence, this cross-sectional study aimed to assess the extent of the prevalence of anemia and the impact of underlying factors among adolescent girls. Three hundred college-going adolescent girls from Ganjam district, Odisha, constituted the samples. The study reported a high prevalence (>90%) of anemia. About half of the anemic adolescents were underweight, and a majority (> 70%) belonged to the upper lower socio - economic class. Except for Body Mass Index and prevalence of clinical signs, no other socio-economic variables and food consumption patterns show any statistically significant association with the severity of anemia. The study concluded with suggestions to develop strategies to improve the socio-economic condition of the population, supported by nutrition education and anemia prophylaxis programs.

Keywords: Adolescent girls, hemoglobin, anaemia, BMI, anthropometric measurement, socio-economic class.

INTRODUCTION

Anaemia is a global public health concern (WHO, 2023). Every fourth individual aged between 10-24 years (roughly 430 million) across the globe suffers from anemia (Azzopardi *et al.*, 2019), and in the South-East Asia region, the prevalence ranges from 27 %- 55 %. (UNICEF, 2011). Anemia, which is characterized by the reduction in the number of red blood cells or the hemoglobin concentration below 12.0 g/dl, is multi-factorial and complex in etiology (Cappellini *et al.* 2020). Poor nutrition, particularly a diet deficient in iron is the principal underlying factor in more than 60% of all anemia cases (Kassebaum, 2016). The vulnerability of adolescents to anemia is mainly due to the increased biological demands for micronutrients like iron and folic acid associated with rapid physical growth. In addition, females remain vulnerable to anemia due to menstrual blood loss (Sudfeld *et al.,* 2020).

Males regain adequate nutrient stores rapidly at the end of adolescence, while females continue to be anemic or become more anemic due to increased micronutrient requirements from menstrual loss and teenage pregnancy (Cappellini *et al.* 2020). NFHS (5) estimates indicate that the prevalence of anemia among adolescents aged 15~19 years has reached 59.1% among girls, and 31.1% among boys (IIPS, 2022). As the years between childhood and adulthood represent a sensitive period for developmental, physiological, and behavioral changes, anemia in this formative phase of life can reduce work capacity, impair neurocognitive and pubertal development and increase susceptibility to infections (Scott *et al.,* 2018). In addition to increased morbidity and reduced work capacity, anemia is associated with poor cognitive and motor development in children and an increased risk for maternal mortality (WHO, 2021). Anemia can also result in poor reproductive health outcomes among teenage girls (Kapil *et al*., 2019; Hargreaves *et al.,* 2022; Samson *et al.,* 2022; Nguyen *et al.,* 2022).

In 2012, the World Health Assembly Resolution 65.6 endorsed a Comprehensive Implementation Plan on Maternal, Infant, and Young Child Nutrition (CIP), with six Global Nutrition Targets for 2025. The second target of which, is a 50% reduction of anemia in women of reproductive age (15-49 years) (Rai, 2022). Anaemia is interlinked with other Global Nutrition Targets; stunting, low birth weight, exclusive breastfeeding, and wasting. Targeted actions are required to reach the anemia target by 2025, and the 2nd and 3rd Sustainable Development Goals (SDG) of reducing all forms of malnutrition and ensuring healthy lives for all ages by 2025. This requires nutrition-specific interventions for preventing and controlling anemia throughout the life cycle. Nutrition education programmes designed for adolescents play a significant role in the improvement of knowledge and perception levels related to anemia (Rani *et al*., 2022).

There are limited data available to appraise the anemia situation among adolescents of Odisha state in general and Ganjam district in particular. Efforts to understand

the anemia status and its causative factors towards this public health problem in adolescents could help to develop early strategies to prevent adverse health-related outcomes. Hence, this study aimed to assess the extent of anemia prevalence and determine its associated factors among adolescent girls of Ganjam District, Odisha, so that appropriate and timely action can be planned to achieve the targets for anemia as mentioned by WHO and SDG.

MATERIAL AND METHODS

Research Design and Sampling

The present study is a cross-sectional work using descriptive approach conducted among college-going adolescent girls of Ganjam district, Odisha, aged between 15–19 y. Four colleges of semi-urban areas of Ganjam district, Odisha, were selected purposefully. Three hundred respondents were selected randomly for the present study.

Inclusion criteria. All unmarried adolescent girls aged between 15–19 years who had given willingness and had participated in health camps organized at the college level.

Exclusion criteria. All boys and other girls not within the age range of 15–19 years and who declined to give willingness were not covered in this study.

Outcome variable. The hemoglobin (Hb g/dl) estimation was done by trained pathologists, one of the team members of the health camps organized at the respective colleges. Anemia was detected if the hemoglobin (Hb) level was below 12 g/dl (WHO, 2011). The respondents were placed in different grades of anemia using the WHO classification (Table 1).

Table 1: WHO classification of prevalence of different grades of Anaemia based on hemoglobin level of the respondents (WHO, 2011).

Hemoglobin level (g/dl)	Grades of anemia
≥12	Non anemic
11-11.9	Mild
8-10.9	Moderate
< 8	Severe

Explanatory variables. Socio-demographic characteristics like age, educational status of the parents, family size, parental occupational status, family monthly income, anthropometric indices; food consumption pattern and food habits, and presence of clinical signs etc. were recorded from the sample population through the questionnaire and careful observation.

Data collection and analysis. The survey was carried out for four months i.e., from November 2021 to February 2022. A self-developed, pre-tested, semi-structured questionnaire was used containing items relevant to the study objectives viz. demographic details like age, family size, educational qualification and occupation of parents, family income, food habits, meal pattern, and food consumption pattern, etc. All the households of sample area were classified into different socio-economic classes based on the Modified Kuppuswamy Scale for the year 2022 (Kumar *et al.*, 2022).

Anthropometric measurements like weight and height of the respondents were recorded following standard protocols. Height was recorded using standard measuring tapes and weight was recorded using a digital weighing balance. The body Mass Index (BMI) status of the respondents was then calculated using the formula: BMI = Weight (Kg)/Height (m^2). The respondents were then categorized as underweight, normal, overweight, and obesity based on the standard classification (WHO, 2010) (Table 2). The mean BMI and 95% Confidence Interval (CI) for each group were then calculated using bivariate analysis.

Statistical analysis. Mean, standard error (SE), frequencies, percentages, range values, and 95% confidence interval and cross-tabulation were used to present the descriptive data. The chi-square test was used to test the significance of associations between the prevalence of anemia with BMI and different socio-demographic characteristics like age, family size, mother's education, and socio-economic class. The extent of correlation has been calculated for the prevalence of anemia with food consumption patterns and clinical symptoms. A p-value < 0.05 was considered to be statistically significant. Statistical Package for Social Sciences (SPSS, version 16.0) was used to perform all the statistical analyses.

Table 2: WHO classification of nutritional status of the samples based on BMI (WHO, 2010).

BMI (Kg/m^2)	Nutritional status
< 18.5	Underweight
18.5–24.9	Normal weight
25.0–29.9	Over weight
≥30.0	Obesity

RESULTS AND DISCUSSION

Socio-demographic characteristics. The demographic and socio-economic characteristics of the respondents (Table 3) reveal that more than 80% of the respondents were Hindu by their religion and about two-thirds of them belonged to other backward classes. The majority of respondents in the present study belonged to nuclear families, which is in line with the findings of Johnson *et al.* (2020), among the adolescents of Bangalore Urban District. Above 90% of respondents belonged to families with 4-6 members, with an average family size of 5.12. In a similar study, Handiso (2022) observed that the adolescent girls in Southern Ethiopia belonged to families with an average size of 6.56 ± 1.83 members.

The education standard of the parents was noticed to be poor, as about 30% of fathers were either illiterate or up to middle standard and only 50% of fathers have obtained education up to high school level. Less than 10 % of fathers have education above the matriculation level (Table 3). Similarly, more than 80% of mothers either had no education or education up to middle standard and there was not a single mother having a graduation degree.

Table 3: Demographic and socio- economic characteristics of the respondents.

Characteristics	Levels	Frequency (%)
Religion	Hindu	242 (80.66)
	Christian	51 (17)
	Others	07 (2.33)
Caste	General	42 (14)
	SC	54(18)
	OBC	198(66)
	ST	06 (02)
Family type	Nuclear	235 (78.33)
	Joint	165(55.0)
Family size (No of family members)	< 4	13 (4.30)
	4 – 6	275 (91.70)
	> 6	12 (4.00)
Father's education	Illiterate	36 (12.00)
	Primary	42 (14.00)
	Middle	45 (15.00)
	High school	148 (49.30)
	Intermediate	14 (4.700)
	Graduate	15 (5.00)
Mother's education	Illiterate	68 (22.70)
	Primary	113 (37.70)
	Middle	67 (22.30)
	High school	48 (16.00)
	Intermediate	4 (1.30)
	Graduate	0 (0)
Socio Economic Class	Upper	0 (0)
	Upper Middle	0 (0)
	Lower middle	64 (21.30)
	Upper lower	226 (75.30)
	Lower	10 (3.30)

Classification of the families into various Socio-Economic Classes following the Modified Kuppuswamy Scale for the year 2022 (Kumar *et al.*, 2022) resulted in a majority (>75%) of the respondents belonging to upper-lower class families and a very few percentages (about 3 %) belonged to a lower class. Not a single household was placed either in the upper or upper middle class. Contrary to this, Johnson *et al.* (2020) observed more than half (51.4%) of the adolescents in Bangalore Urban District belonged to the upper middle or upper socio-economic class.

Prevalence of Anaemia among the respondents. A study on the prevalence of anemia among the sample population recorded as high as 93% of the sampled adolescent girls to be anemic (Table 4). Classification of anemic girls into different degrees of anemia showed that more than 50% of respondents were in the moderate anemia category with a mean hemoglobin level of 9.449±0.027 g /dl (95% CI: 9.395-9.502), followed by 40 % in the mild category with a mean hemoglobin level of 10.604±0.042 g /dl, (95 % CI: 10.519-10.688). No case of severe anemia was recorded among the respondents in the present study (Table 4). The mean anemic level of different groups is found to be statistically significant, as the mean values of the non-anemic, mild, and moderate category are lying within the confidence interval of 95 % (Table 4).

Table 4: Prevalence of Anaemia among the respondents.

Anaemic Group		Reference range of Hb (g/dl)	Frequency (%)	Observed range of Hb (g/dl)	Mean Hb (g/dl) (95% CI)
Non-anaemic (Normal)		≥ 12.0	21 (7.00)	12.00-12.60	12.195±0.047 (12.096-12.294)
Anaemic	Mild	11.99 - 10.0	122 (40.70)	10.00-11.80	10.604±0.042 (10.519-10.688)
	Moderate	9.99 - 8.00	157 (52.30)	8.40-9.90	9.449±0.027 (9.395-9.502)
	Severe	< 8.0	0 (0.00)		
		Total	**300 (100.00)**		

Verma *et al.* (2021); Johnson *et al.* (2020); Hamal *et al.* (2018) also observed the prevalence of anemia in nearly fifty percent of the adolescents from their respective studies. A high prevalence of anemia (95% CI: 66.3-77.1) was observed by Subramanian *et al.* (2022) among adolescent girls residing in rural Haryana. Among them, about 40% were identified with a moderate level of anemia, followed by 25.7% cases of mild and very few cases (4.8%) of severe anemia. A similar observation of a high prevalence (87%) of anemia with a mean Hb level of 10.1 g/dl among adolescent girls from rural Maharashtra has been made by Ahankari *et al.* (2017). They recorded a prevalence of mild, moderate, and severe anemia among 17%, 65%, and 5% of respondents, respectively.

On the other hand, a low prevalence of anemia among adolescent girls was observed by several researchers. Mengistu *et al.* (2019) reported only 11.1% of adolescent girls in Bahir Dar city as anemic. Kounnavong *et al.* (2020) also made a similar observation of low anemia prevalence among the adolescent girls of Lao with a mean hemoglobin concentration of 13.2 g/dl. Handiso (2022) observed the prevalence of moderate category of anemia among 37.2% of adolescent girls in Southern Ethiopia, with a mean (± SD) hemoglobin level of 12.23 ± 1.16 g/dl. Similarly, Sari *et al.* (2022) observed the prevalence of anemia among 21.1% of adolescent girls in West Java, Indonesia with an average hemoglobin level of 10.75 ± 0.79 g/dl. At the national level, the findings of the National Family Health Survey (NFHS) -5 revealed that there has been an increase in the prevalence of anemia among adolescent girls aged 15-19 years of India compared to the previous NFHS-4 survey from 54 % to 59% (IIPS, 2022). On this back drop prevalence of anemia among 93% of adolescent girls in the sampling area of this study seems to be alarming.

BMI status of the respondents. Calculation of the Body Mass Index (BMI) of the respondents (Table 5) revealed that the highest numbers of respondents (> 50%) were found to be under-weight with a mean BMI of 17.162±0.106 (95% CI:16.950-17.373), followed by normal category (43%) with mean BMI of 20.701±0.118 (95% CI: 20.465-20.935). Less than 7

percent of respondents were distributed either in the overweight or obesity category. The average BMI of the entire sample was calculated as19.327±0.175 (Table 5). A similar observation has been reported by researchers like Johnson *et al.* (2020); Ahankari *et al.* (2017) from their respective studies, who have reported more than 60 % of adolescents as underweight.

Prevalence and degree of anemia in different BMI categories were cross analyzed and observed that about 50% of adolescents with anemia were under-weight (Table 6). Not a single overweighed and obese adolescent was detected with a moderate degree of anemia. Further, out of 40 % of adolescents identified with mild anemia, more than 28% of the total population was in the normal weight category. All most all the adolescent girls belonging to the non-anemic group are in the normal BMI group (Table 6).

Table 5: Classification of respondents according to their BMI status.

BMI Status	Frequency (%)	Range of BMI	Mean (95% CI)
Under- weight	151 (50.33)	13.91-19.93	17.162±0.106 (16.950-17.373)
Normal	130 (43.33)	18.08-25.02	20.701±0.118 (20.465-20.935)
Over-weight	13 (4.33)	25.02-26.00	25.334±0.104 (25.107-25.561)
Obesity	6 (2.00)	30.27-32.29	31.058±0.321
Total	300	13.91-32.29	19.327±0.175

Table 6: Cross tab analysis between BMI status and different degrees of Anaemia.

BMI status	Degree of Anaemia			Non- anaemic	Total (%)
	Severe	Moderate	Mild		
Under- weight	0	131(43.66)	19 (6.33)	1(0.33)	151 (50.33)
Normal	0	26 (8.66)	85 (28.33)	19 (6.33)	130 (43.33)
Over-weight	0	0	12 (4.0)	1 (0.33)	13 (4.33)
Obesity	0	0	6 (2.0)	0	6 (2.00)
Total	**0**	**157 (52.30)**	**122 (40.70)**	**21 (7.00)**	**300 (100.00)**

Association of anemia severity with various Socio-Demographic Factors and BMI. Association of Anaemia status with various Socio-Demographic factors and BMI as established using Chi-square tests inferred that the majority of respondents identified with anemia belonged to upper lower socio-economic class, with mothers educated up to primary level and families with 4-6 members (Table 7). The least anemic cases were in lower-class families with mothers educated up to the intermediate level. None of these variables showed any statistically significant association with the prevalence of anemia. The findings of this study are in line with the findings of Johnson *et al.* (2020); Kounnavong *et al.* (2020).

There are few studies such as Subramanian *et al.* (2022); Verma *et al.* (2021); Hamal *et al.* (2018), have established a significant association between socio-demographic characteristics, particularly parental education with the prevalence of anemia in their independent studies. Shaka and Wondimagegne (2018) have also emphasized the importance of parent education in reducing anemia among adolescents. On the other hand, Mengistu *et al.* (2019) observed that family income had a positive association with the prevalence of anemia among adolescents. Similarly, Ford *et al.* (2020); Mistry *et al.* (2017) from their respective studies observed that increased household wealth reduces the chances of anemia among adolescents.

The BMI status of the respondents showed a highly significant association ($p < 0.01$) with the prevalence of anemia among the adolescents in the study area. The highest number of anemia cases (50%) were observed among the under weighed adolescents and 37 % of cases with normal BMI status were found to be anemic. Only about 6 % of anemia cases were observed either in the overweight or obesity category. In agreement with our findings, Verma *et al.* (2021); Gebreyesus *et al.* (2019) observed a significant association between BMI category and anemia status ($p<2.2e-16$). Working on adolescent girls in southern Ethiopia, Handiso (2022) concluded that BMI for age is one of the main predictors of low blood hemoglobin levels among adolescent girls. A significant association of Hb levels with MUAC, weight, and height was reported by Sari *et al.* (2022).

Food habits, meal patterns, and severity of anemia. More than sixty percent of respondents in the present study were found to include non-vegetarian foods in their diet (Table 8). The highest number of respondents (> 46%) were following two meal patterns per day taking lunch and dinner only and 32 % of respondents were observed to include breakfast in their daily meal pattern, while only a small percentage of respondents (about 21%) were following 4 meal pattern per day. Kounnavong *et al.* (2020) also reported three meal or above pattern among 79.6% of the adolescents in Lao PDR. Belagavi and John (2020) attributed poor nutritional status in rural areas to the higher prevalence of anemia among children. However, Johnson *et al.* (2020); Siva *et al.* (2016) did not find any significant association between nutritional status and anemia in their respective studies. Pattan *et al.* (2020) observed that maximum (70%) adolescent girls in Goraj village

of Vadodara found to take mixed diet and minimum (30%) girls took vegetarian diet.

The consumption pattern of the foodstuffs rich in protein and iron (Table 8) shows that less than 10 % of respondents were found to consume jaggery, pulses, and greens daily. About half of the respondents were observed to consume jaggery on weekly basis. Nearly 80 % of respondents were found to consume green leafy vegetables 2 to 3 times a week. About 30 % of the respondents were found to consume pulses 2 to 3 times per week and another 30% of respondents were found to consume pulses only once a week. Similar was the case with greens, which were consumed approximately by 30 % of respondents once a week. In agreement with our findings, Kounnavong *et al.* (2020) reported low consumption of fruit (94.8%) and vegetables (88.1%) among the adolescents in their study area.

Correlations between the severity of anemia with food consumption pattern among the respondents (Table 9) shows that the severity of anemia decreases with the increase in the frequency of meal per day and consumption of jaggery and green leafy vegetables per week. However, the consumption of pulses showed a positive correlation with anemia severity. There are several studies indicating the relationship between food consumption patterns and anemia. Ahankari *et al.* (2017) observed that ≥3 days/week consumption of fruit (OR: 0.35, 95% CI: 0.23–0.54) or rice (OR: 0.39, 95% CI: 0.17–0.910.91) was associated with decreased anemia risk. Sari *et al.* (2022) with multivariate logistic regression analysis showed a positive association of protein intake (OR=0.25; 95% CI 0.11– 0.58) with anemia. Mistry *et al.* (2017) stated that adolescents from poor households consume less diversified diets with poor micronutrients, resulting in higher anemia. However, Johnson *et al.* (2020); Kounnavong *et al.* (2020) observed no significant correlation between anemia and fruit and vegetable consumption, and daily meal frequency. Similarly, the correlation observed between the severity of anemia and the food consumption pattern of the respondents in this study was not statistically significant (p>0.05).

Prevalence of clinical symptoms with the severity of anemia. Cross-tab analysis on the prevalence of clinical signs and symptoms with the severity of anemia among the respondents (Table 10) shows that the various clinical signs like pallor in the skin, conjunctiva paleness, tiredness, and dull hair were observed only among 22 to 32 percent of respondents, who had been diagnosed with moderate anemia. No respondents with mild anemia or non-anemia (i.e., normal cases) had any of the above symptoms. Analysis of the correlation coefficient (Table 11) observed a statistically significant correlation (p<0.01) between the prevalence of the various clinical signs with that of anemia among the respondents.

Table 7: Association of anaemia status with various Socio-Demographic Factors and BMI.

Characteristics	Levels	Anaemic	Non- anemia	Chi-sq value	Df	P value
Family size (No. of members)	<4	13 (4.3)	0 (0.0)	2.052	2	0.358
	4-6	254 (84.7)	21 (7.0)			
	>6	12 (4.0)	0 (0.0)			
Mother's education	Illiterate	64 (21.3)	4 (1.3)	6.331	4	0.175
	Primary	105 (35.0)	8 (2.7)			
	Middle	65 (21.7)	2 (0.7)			
	High school	41 (13.7)	7 (2.3)			
	Intermediate	4 (1.3)	0 (0.0)			
	Graduate	0 (0.0)	0 (0.0)			
Socio Economic Class	Lower middle	59 (19.7)	5 (1.7)	0.248	2	0.883
	Upper lower	211 (70.3)	15 (5.0)			
	Lower	9 (3.0)	1 (0.3)			
BMI Status	Under weight	150 (50.0)	1 (0.3)	21.358**	3	0.000
	Normal	111 (37.0)	19 (6.3)			
	Over weight	12 (4.0)	1 (0.3)			
	Obese	6 (2.0)	0 (0.00)			

Table 8: Food habit and meal pattern of the respondents.

Characteristics		Levels	Frequency (%)
Food habit		Vegetarian	112 (37.33)
		Non Vegetarian	188 (62.66)
Meal Pattern		Two meal pattern (lunch + dinner)	139 (46.33)
		Three meal pattern (breakfast +lunch + dinner)	96 (32.00)
		Four meal pattern (breakfast + lunch + snack + dinner)	65 (21.66)
Consumption pattern of protein and iron rich foods	Jaggery	Daily	28 (9.30)
		Weekly 2-3 times	84 (28.00)
		Weekly once	149 (49.70)
		Occasionally	39 (13.00)
	Pulses and beans	Daily	29 (9.60)
		Weekly 2-3 times	93 (31.00)
		Weekly once	98 (32.70)
		Occasionally	77 (25.70)
	Green leafy vegetables	Daily	10 (3.30)
		Weekly 2-3 times	148 (79.30)
		Weekly once	87 (29.00)
		Occasionally	55 (18.30)

Table 9: Correlations between severity of anaemia and food consumption pattern.

	Anaemia	Meal pattern	Greens	Jaggery	Pulses
Anaemia	1				
meal pattern	- 0.011	1			
Greens	- 0.031	0.161**	1		
Jaggery	- 0.110	0.088	- 0.010	1	
Pulses	0.054	- 0.586**	- 0.107	- 0.025	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 10: Cross tab analysis between severity of anaemia and disease symptoms.

Severity of Anaemia	Skin pallor		Pale conjunctiva		Tiredness		Dull hair	
	Present	Absent	Present	Absent	Present	Absent	Present	Absent
Moderate	68	89	78	79	96	61	69	88
Mild	0	122	0	122	0	122	0	122
Normal	0	21	0	21	0	21	0	21
Total N0 (%)	**68 (22.66)**	**232**	**78 (26.0)**	**222**	**96 (32.0)**	**204**	**69 (23.0)**	**231**

Table 11: Correlations between prevalence of anaemia and disease symptoms.

	Anaemia	Skin pallor	Pale conjuctiva	Tiredness	Dull hair
Anaemia	1				
Skin pallor	0.149**	1			
Pale conjunctiva	0.163**	0.895**	1		
Tiredness	0.188**	0.789**	0.864**	1	
Dull hair	0.150**	0.915**	0.922**	0.797**	1

**. Correlation is significant at the 0.01 level (2-tailed).

CONCLUSIONS

The Study on the prevalence of anemia among the sample population recorded as high as 93% of the adolescent girls were anemic belonging to mild and moderate categories. The highest numbers of anemia cases (50%) were under-weighed adolescents and a majority (> 70%) of anemic respondents belongs to upper lower socio-economic class. No statistically significant ($p>0.05$) correlation was observed between the severity of anemia and their food consumption pattern, but a highly significant correlation ($p<0.01$) between the prevalence of the various clinical signs with that of anemia was observed among the sample population particularly those diagnosed with moderate anemia. Hence it may be concluded from the study that the low socio-economic class of the respondents may be the contributing factor for the prevalence of anemia to such an extent among the adolescent girls in the study area.

FUTURE SCOPE

Study like this might be helpful in planning appropriate and timely action to achieve the targets for anemia as mentioned by WHO and SDG.

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