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An Investigation On The Prevalence Of Anaemia Among Rural Adolescent Students Of West Bengal, India

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Abstract:
Anemia among adolescents causes impaired cognitive performance, motor *coordination, behavior and motor development, academic achievement, and language development as well as impaired growth, developmental delay, decreased physical activity, and increased morbidity from infectious diseases. The present study was undertaken to investigate anemia prevalence among adolescent students in West Bengal. This study was conducted on 253 subjects of which 128 were boys and 125 were girls in the age group of 12-15 years, selected from different districts of West Bengal state in India. Anthropometric measures and physiological parameters were measured from the subjects by using standard techniques. The prevalence of anemia was very high among the subjects and more than the global prevalence. There was a significant difference in mean hemoglobin content among different FIG groups. FIG I had the lowest mean hemoglobin content while FIG III had the highest mean hemoglobin content. There was an increasing trend in anemia prevalence with decreasing monthly family income. The Odd ratio became higher in the FIG I group than in the FIG II and FIG III groups of both sexes. Improving overall nutritional status and access to resources of their family will have the greatest impact on reducing anemia. Iron supplementation programs can reduced the anemia prevalence. Awareness about A diet plan with the low-cost iron-rich foods may be another solution to the problem among the rural population. Health nutrition education by school teachers, changes in the Midday Meal menu, and the development of the kitchen garden on school campuses will have the greatest impact on reducing anemia prevalence.*

Key word: *Adolescent, anemia, monthly family income, prevalence*

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I. Introduction

The rural population in India faces considerable disparity as compared to the urban population in terms of medical facilities, educational facilities, health facilities, and economic pursuits[1]. In developing countries like India, poverty and scarcity of food are greater, awareness of diseases nonexistent and it appears that the diseases, viz., anemia, hypertension, diabetes, obesity, depression, and undernutrition may be equally prevailing in poor people[2,3,4]. Anemia continues to be a major public health problem worldwide; particularly most affected are children and women in both developed and developing countries and it is an indicator of malnutrition and poor health for human health as well as for the socio-economic development of a population[5,6]. More individuals have been suffering from iron-deficiency anemia at any given moment than any other health problem worldwide[7]. Globally, anemia prevalence was 29.9% in women of reproductive age (15-49 years), 29.6% in non-pregnant women of reproductive age, and 36.5% in pregnant women in 2019[8]. Globally, anemia prevalence was 39.8% in children aged 6-59 months in 2021, which is equivalent to 269 million children [8]. The prevalence of anaemia in children under five was 60.2% in 2021, which was the highest in the African Region[8]. Anemia is one of the most common public health problems in India, which is much more prevalent in the rural population than the urban[9]. Nutritional anemia is a critical public health problems in India that affects almost poor women, adolescent girls, and children[9]. National Family Health Survey (NFHS) studied the prevalence of anemia among pregnant women in India and reported that 50 percent of pregnant women were anaemic in India, India had the highest prevalence of anaemia in pregnancy among South Asian countries[10]. Smaller-scale studies on micronutrient deficiency conducted in India revealed that the prevalence of anemia was high among adolescent[11-14].

Haematological parameter like haemoglobin (Hb) is generally known to be affected by socioeconomic conditions, especially via nutrition, as the nutritional status largely depends upon the socioeconomic condition and cultural norms[15,16]. In India, the rural population is mostly subjected to low bio-availability of iron because of the cereal-based diet and chronic blood loss from hookworm infestations which results in anemia[17,18].

Anemia is associated with decreased muscular strength, lowered physical activity, weakness, fall injury, and mental capacity, increased morbidity from infectious diseases, increased frailty risk, maternal,

perinatal and neonatal mortality, inadequate storage iron of the newborn, premature delivery, low birth weight, impaired cognitive performance, and motor development among children[19,20]. There is convincing evidence that iron deficiency and anemia among young children and adolescents was a matter of serious concern because it impaired cognitive performance, behavioral and motor development, co-ordination, language development, and scholastic achievement which resulted in a lower Intelligence Quotient (IQ) and behavioral abnormalities, as well as impaired growth, developmental delay, decreased physical activity, and increased morbidity from infectious diseases[21,22]. Anemia in childbearing females has been associated with the higher risk of maternal morbidity and mortality, perinatal and neonatal mortality, preeclampsia, inadequate iron stores for the newborn, preterm birth, and low birth weight[20,23].

The adolescent population is experiencing a tremendous amount of changes in physical development, although development is continuous, the rate at which this development occurs may vary in individual case[24]. Physical changes in the body are taking place in adolescent girls, along with rapid sexual development[25,26]. Adolescents need more nutrients and energy due to the increased height and weight and their heightened physical growth also depend upon socioeconomic status[27,28]. It is also a time when the physiological needs for energy and nutrients are increased and the consumption of a diet with proper nutrition is important [29]. Several investigators have demonstrated an association between physical development in the adolescent period with nutritional and socioeconomic status[29-31]. Several recent studies have been carried out in different states in India on the nutritional status of adolescent.[32-35]. However, studies on anemia among the rural adolescent population in relation to the economic status of the family in West Bengal state are scanty[36,37]. Taking the above issues into consideration, the present study was therefore undertaken to investigate the prevalence of anemia among adolescent boys and girls in West Bengal state and to examine the possible association of the prevalence of anemia among adolescents with the economic status of the family.

II. Materials and Methods

Selection of site and subjects: This cross-sectional descriptive study was conducted on 253 subjects of which 128 were boys and 125 were girls in the age range of 12-15 years, selected from different schools of Howrah, East, and West Midnapore districts of West Bengal state, India. Ethical approval and prior permission were obtained from the institutional Ethics Committee before the commencement of the study and the study was performed in accordance with the ethical standards of the committee and with the Helsinki Declaration.

Sampling design: Two-stage sampling method was utilized. In the first stage, the cluster sampling method was used to identify 5 clusters (schools) in each district e.g., Midnapore (East and West), and Howrah of West Bengal, India. In the second stage, a systematic random sampling method was used to identify 20 students (boy-10; Girl-10) per cluster. All the students (Standard VII to Standard X) in the cluster were listed and the number of students was divided by the required number of students to get the sampling interval. The first student was selected randomly by using the lottery method and then subsequent students were identified by adding the sampling interval to the random number. The selected students were approached during field visits and the protocol of the study was explained verbally in the local language (Bengali) and they were selected as participants. It was reported that apparently healthy students who were not suffering from any acute illness and were self-satisfied with their normal day-to-day work schedule at the time of measurements were enrolled as participants in the study. Informed consent was obtained from the school, local Panchayat, and the parents.

Age estimation: Assessment of age most essential for conducting growth studies. The accurate age of the adolescent students was recorded from the school registration books.

Socioeconomic Status: The socioeconomic status of the parents of the students was evaluated by a modified Kuppuswami scale[38]. From the response of the subjects, the total monthly income of the family was noted. The socioeconomic status of the parents was determined by the scores suggested in this scale. The score obtained by each person in education, occupation, and income was added to get the final score, and accordingly, the parents were categorized. Five different categories from the lower to upper have been suggested in this scale. Monthly family income was recorded in rupees (Rs.). The current exchange rate is US $1 = 82.3275 INR (Approximate). The subjects were further classified into the following three family income groups (FIG) according to their monthly family income (MFI):

FIG I: Rs. ≤5,000
FIG II: Rs. 5,001–9,999
FIG III: Rs. ≥10,000

Measurement of anthropometric dimensions: Height and weight of the participants were measured using standard methodology. Height was measured by using an anthropometer (Hindustan Minerals) and weight was measured by using a portable weighing machine (Libra). From measuring the height and weight of the participants, the body mass index (BMI) was computed using the following standard equation:

BMI= Weight (kg) / Height^2 (m)

Determination of Hemoglobin Concentration: The hemoglobin (Hb) status was measured with a finger prick sample of capillary blood and analyzed immediately using a hemoglobinometer. Both boys and girls were classified as mildly, moderately, or severely anemic based on their hemoglobin status following international reference[39]. Anemia was defined as Hb of <12g/dl. Mild anemia was defined as Hb of 10 –11.9 g/dl. Moderate anemia was defined as a Hb of 7-9.9 g/dl and severe anemia as a Hb of < 7 g/dl.

Determination of Blood Pressure: Blood pressure was measured by auscultatory method, with the help of a sphygmomanometer (mercury type) and a stethoscope[40]. Resting systolic and diastolic blood pressures of the subject were measured after taking a rest in a sitting position for at least 15 min prior to measurement and again at least 10 min after the first reading. The mean values of three measures were used in analyses. The mean arterial pressure (MAP) was calculated from the formula, MAP = DBP + ⅓ (SBP – DBP).

Determination of Breathing Rate and Pulse rate: The breathing Rate and Pulse rate of the subjects were determined by standard technique[41-43].

Statistical analysis: The sample size was determined by the standard formula ($n=z^2pq/d^2$) [44]. The minimum estimated sample size was 210 [$(1.96^2\times0.837\times0.163)/0.05^2$]. The calculation was based on 83.7% prevalence (p) of anemia among rural Bengali students [45] with desired precision (d) of 5%. Where, q = p-1and z = 1.96. Data were presented by sex. Age, anthropometric measures, and hemoglobin content were described by their means and standard deviations. To test the significance of the difference of different parameters, the student t-test was performed. A Chi-square analysis was done to determine the differences in the prevalence of anemia among the sexes and different family income groups. One-way analyses (Scheffe's procedure) were carried out to test differences in mean hemoglobin content across the three economic categories. The odd ratio (OR) was calculated to determine the change in the prevalence of anemia with respect to family income groups. Statistical significance was set at $p<0.05$.

III. Results

The socioeconomic status of the parents was evaluated by the modified Kuppuswami's scales as already mentioned. From the results of the present study, it was noted that the majority of the parents belonged to the lower socioeconomic category (64.82%). 25.69% of the parents belonged to the lower middle socioeconomic category. Only a notable percentage of the parents belong to the upper middle category (9.49%).

The physical and physiological characteristics of the students have been shown in Table 1 according to sex. The mean ages were 13.48±1.11 years and 13.42±1.12 years for boys and girls respectively. No significant difference in mean age was obtained between the sexes. The hemoglobin content was significantly higher ($p<0.05$) in boys compared to girls. However, no significant difference was obtained in other physical and physiological characteristics between the sexes.

Table 1: Physical and physiological characteristics of the subjects

Parameters	Boy (n=128) (Mean±SD)	Girl (n=125) (Mean±SD)
Age (years)	13.48±1.11	13.42±1.12
Height (cm)	145.38±7.93	143.96±6.27
Weight (Kg)	36.71±6.06	35.44±6.05
BMI (Kg/m^2)	17.32±2.26	17.06±2.42
Hemoglobin (g/dl)	10.23±2.24	9.59±2.14*
Breathing rate (breaths/min)	19.33±1.84	19.70±2.18
Pulse rate (beats/min)	77.83±5.71	78.79±6.78
Systolic blood pressure (mm Hg)	106.77±11.70	104.07±12.70
Diastolic blood pressure (mm Hg)	71.14±8.53	70.21±8.96
Mean blood pressure (mm Hg)	83.02±9.11	81.50±9.31

With respect to Boy *p<0.05

The prevalence of anemia was studied among the study population based on WHO-prescribed hemoglobin cutoff values as mentioned earlier [39] and it was found that the prevalence of anemia was very high among both boys and girls (boy 73.44%; girl 83.2%). Again the subjects were divided into three anemia groups viz. mild anemia, moderate anemia, and severe anemia based on WHO-prescribed hemoglobin cutoff value. Among the study population, about 39.06% of boys and 36% of girls belonged to a mild anemia group and about 25.78% of boys and 29.6% of girls belonged to a moderate anemia group respectively. The occurrence of severe anemia cases among the study population was 8.59% in boys and 17.6% in girls respectively. The results also indicated that the prevalence of severe anemia cases was significantly higher ($p<0.05$) in girls than the boys.

Table 2: Frequency (f) and percentage (%) of male and female having different categories of anemia

Anemia classification	Frequency (f)		Percentage (%)	
	Male	Female	Male	Female
Severe (Hb. < 7 g/dl)	11	22	8.59	17.6
Moderate (Hb.7-9.9 g/dl)	33	37	25.78	29.6
Mild (Hb.10 –11.9 g/dl)	50	45	39.06	36.0
All categories (Hb. <12g/dl)	94	104	73.44	83.2

The subjects were further classified into three family income groups (FIG), viz., FIG I: Rs. ≤5,000; FIG II: Rs. 5,001–9,999 and FIG III: Rs. ≥10,000 according to their monthly family income (MFI). From the results, it was noted that 32.03% of boys and 36% of girls belonged to the FIG I group and 38.28% of boys and 38.4% of girls belonged to the FIG II group, while 29.69% of boys and 25.6% of girls belonged to the FIG III group respectively.

The hemoglobin content of the subjects of different FIG groups was also studied and table 3 presents the mean values of hemoglobin by FIG categories. From the results, it was revealed that significant differences (Boy: $F=7.905$, $p<0.001$; Girl: $F=12.032$, $p<0.001$) in hemoglobin contained were observed among the FIG categories. Subjects belonged to FIG III had significantly higher hemoglobin content (Boy: 11.25 g/dl; Girl: 10.72 g/dl) compared to the subjects belonged to FIG II ($p<0.05$) as well as FIG I ($p<0.001$) categories of both sexes. On the contrary, the subjects belonging to a low-income group (FIG I) had the lowest mean hemoglobin content (Boy: 9.35 g/dl; Girl: 8.54 g/dl) compared to other FIG groups. The mean value of hemoglobin increased steadily from the low-income group (FIG I) through FIG II to the FIG III groups.

Table 3: Hemoglobin content among three family income group (FIG)

Economic group	Boy (Mean±SD)	Girl (Mean±SD)
FIG I: Rs. ≤5,000 (n= Boy: 41; Girl: 45)	9.35±2.21	8.54±2.16
FIG II: Rs. 5,001–9,999 (n= Boy: 49; Girl: 48)	10.18±2.21	9.83±1.76
FIG III: Rs. ≥10,000 (n= Boy: 38; Girl: 34)	11.25±1.90	10.72±1.99
F	7.905 ($p<0.001$)	12.032 ($p<0.001$)

The prevalence of anemia among the subjects of different FIG categories was studied and from the results, it was found that the higher prevalence of anemia was noted among the subjects belonging to the lower income group (FIG I) (Boy: 85.37%; Girl: 91.11%) and FIG II group (Boy: 77.55%; Girl: 85.42%) compared to higher income group (FIG III) (Boy: 55.26%; Girl: 68.75%) (Table 4). The result indicated that there were significant differences in the prevalence of anemia among the categories except between the FIG I and the FIG II groups of both sexes. The result also indicated that there was an increasing trend of anemia prevalence (Boy: $\chi 2=9.85$, $p<0.01$; Girl: $\chi 2=6.964$, $p<0.05$) with decreasing family monthly income.

The Odd ratio becomes higher in the FIG I group than in the FIG II and FIG III of both sexes. In the case of boys, it was about five times higher in FIG I group and about three times higher in the FIG II group compared to the FIG III group. Moreover, it was about two times higher in FIG I group than in the FIG II group. Similarly, in the case of girls, the Odd ratio is about five times higher in FIG I group and three times higher in

the FIG II group compared to the FIG III group. Moreover, the odd ratio was about two times higher in the FIG I group than in the FIG II group.

Table 4: Relationships of FIG with anemia prevalence

Economic group	Boy			Girl		
	Prevalence	Odd Ratio (95% CI)		Prevalence	Odd Ratio (95% CI)	
FIG I: Rs. ≤5,000 (n= Boy: 41; Girl: 45)	85.37%	4.72 (1.11 to 7.07)	1.69 (0.56 to 5.05)	91.11%	4.66 (1.31 to 16.59)	1.75 (0.48 to 6.44)
FIG II: Rs. 5,001–9,999 (n= Boy: 49; Girl: 48)	77.55%	2.80 (1.61 to 13.86)	1	85.42%	2.67 (0.89 to 7.97)	1
FIG III: Rs. ≥10,000 (n= Boy: 38; Girl: 34)	55.26%	1	-	68.75%	1	-
χ^2	9.85 ($p<0.01$)			6.964 ($p<0.05$)		

IV. Discussion

By any measure, India is now one of the poorest country in the world, with a population estimated at more than 1.42 billion and India's total fertility rate (TFR) has declined from 2.2 in 2015-16 to 2.0 in 2019-21 [46]. The fertility rate has declined to 1.6 in urban areas and 2.1 in rural areas which indicating the significant progress of population control measures[46]. However, there have been impressive improvements in health status in the last two decades, as measured by a number of indicators, including a reduction in child mortality rate and a decline in the fertility rate, but nutritional improvements have been less[47]. A large section of the population lives in India remains undernourished[48]. Apart from overall impoverishment, the health status of the Indian rural population reflects the health inequities, unequal resource distribution, low purchasing power of food and unequal sharing of food in the families which makes them vulnerable in society[49]. Undernutrition (underweight, wasting, stunting) and anemia are now globally recognized public health problem and these are the indicators of poor health of a population[18,50,51]. However, there is very little information on the anemia prevalence among the adolescent school children from rural areas of the state of West Bengal. The absence of suitable epidemiological data is the reason why we have attempted to investigate the prevalence of anemia among the adolescent school children from the rural areas of West Bengal.

In the study population, the overall prevalence of anemia was 73.44% in boys and 83.2% in girls, which was more than the global prevalence[52]. The exact figures for the prevalence of anemia vary from study to study, but there is no doubt that anemia is a serious public health problem in India, especially among the rural population. According to the WHO classification of anemia as a problem of public health significance at community levels, the prevalence of anemia, which was >40% was considered to be a severe public health problem, that which was between 20.0 to 39.9% to be a moderate public health problem, that which was between 5.0 to 19.9% to be a mild public health problem and that which was <4.9% to be not a public health problem[53]. The prevalence of anemia among the study population was far-greater than 40%, it was considered as a severe public health problem. The dietary habits and prevalence of various intestinal parasitic infestations and other chronic illnesses were not studied in present study. Moreover, the rural population in India have taken a nutritionally deficient diet and exposed to different diseases due to the insanitary conditions of the environment and they have to wash clothes and utensils in the polluted pond and river water which may have been more susceptible to parasitic infestations and other chronic infections, thus leading to a higher prevalence of anemia[54].

Adolescence is a transitional period of the life cycle associated with change from childhood to adulthood where a multitude of physical and psychological changes occurs[55]. Children experience rapid and significant developmental change during adolescence stage of the life cycle[55]. Physical development relates to the changes in the body and brain**,** including growth, improved both gross (large) and fine motor skills and biological maturity [55]. During adolescence, the body grows faster than any other time, except the first two years of life[55]. Physical growth include significant changes in height, weight, and in the size of internal organ as well as changes in muscular systems[56]. Adolescents are often physically vulnerable due to poor physical fitness, poor diet, poor health habits,[57] and high-risk behaviors, include alcohol, tobacco or illicit drugs intake[58] and sexual experimentation[59]. Anemia causes permanent brain damage, lower school performance, physical and exercise intolerance, and weak immune response[60]. Other report stated that anemia was a major concern in young children because it impaired cognitive functions, development of motor co-ordination and motor behavior,

language achievement and scholastic achievement which resulted in a lower Intelligence Quotient (IQ) scores and behavioral disorders, as well as interruption of growth and increased morbidity from infectious diseases[61].

Recent studies worldwide has established that low socioeconomic status is associated with undernutrition in different populations[62]. The present study attempted to study the possible association of monthly family income with anemia prevalence among rural adolescent student. The results of the present studies showed that there was a significant FIG difference in mean hemoglobin content among the adolescent student. It was observed that FIG I had the lowest mean hemoglobin content among both sexes while FIG III had the highest mean hemoglobin content. The results of the present study indicated that MFI (monthly family income) was associated with anemia prevalence among adolescent student. It also was observed that there was an increasing trend in anemia prevalence with decreasing monthly family income. The findings of this study also highlights the fact that the anemia prevalence was high in individuals belongs to the low FIG group. The Odd ratio became higher in the FIG I group than the FIG II and FIG III groups of both sexes. Therefore, it seems that the low family income has a significant clinical effect on the anemia prevalence. The results of the present study are in concordance with earlier studies from Asia including India[63-65].

V. Conclusion

This study has demonstrated that anemia were highly prevalent among adolescents boys and girls of the state of West Bengal. Thus, there is a need to initiate intervention measures at this group in order to reduce the prevalence of anemia. Improving dietary diversity and their access to resources will have the greatest impact on reducing anemia. Iron supplementation programs, may be effective in reducing the prevalence of anemia. Awareness about the low cost iron rich food among the rural population may be another solution of the problem. School can be the most important strategic place to foster healthy lifestyles and valuable second front in the war against ill health and malnutrition. Unfortunately, health education in rural schools in India is either limited to some routine touching of the syllabus or nonexistent. Health-nutrition education by school teachers may be effective for reducing anemia prevalence among student. Changes in Midday Meal (MDM) menu and development of the kitchen garden in school campuses will have the greatest impact on reducing anemia prevalence.

Study limitation: The current study has certain limitations. In the present study, the prevalence of anaemia among adolescent students were studied. However, some potential confounders, such as the physical activity of the study participants, age of the mother at first birth, mother's BMI, preceding birth interval, diarrhea episode, prevalence of various parasitic infestation, type of food consume and method of feeding, were not studied. There are limitations associated with using cross-sectional data, as in every cross sectional study, conclusions related to cause and effect cannot be drawn. A longitudinal dataset would be better suited to examine the influence of sociodemographic factors on nutritional status of adolescent. However, as far as we are aware, this is the only provincial study to define the relationship between sociodemographic factors and nutritional status of adolescent students. This study was conducted among 12 to 15 year-old children. Additional study is needed for children under 12 years of age.

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