RESEARCH ARTICLE

Prevalence of anemia among college-going female students of Berhampore in Murshidabad district, West Bengal, India: A comprehensive study to explore the contributing factors

Baishali Basak[1,2], Rajen Haldar[1], Tuphan Kanti Dolai[3], Smritiratan Tripathy[2*]

ABSTRACT

Background: Anemia poses a remarkable health challenge worldwide, especially for reproductive-age women in India. The NFHS-4 reported that approximately 63% of reproductive-age women in West Bengal are affected by anemia. In Berhampore town, there is limited evidence concerning the prevalence of anemia and its contributing factors among reproductive-age women. *Objectives*: This work aimed to find out the notable gap in anemia research among college-going reproductive-age women (18–23 years) of Berhampore Girls' College, West Bengal, India. The objectives were to explore the prevalence of anemia and its contributing factors. *Methods*: This study was conducted on 90 volunteers. Sociodemographic background, economic status, educational qualification of parents, food habits, and anthropometric parameters were analyzed. Anemic patients were screened based on blood hemoglobin concentration. The statistical analysis was carried out using standard statistical tools. *Results*: This study indicates that 75.55% of female students are anemic, and, the prevalence of anemia is higher (86.36%) among the rural population. The sociodemographic background, economic condition, parents' education, and food habits are very poor compared to urban women. However, the anthropometric variables were not correlated with anemia in either of the populations. *Conclusion*: Anemia is more prevalent in rural populations possibly due to their poor socio-economic condition and insufficient food intake. Improving education, economic stability, and access to nutritious foods may help to combat the rising prevalence of anemia in rural areas.

Keywords: Anemia, Rural population, Hemoglobin concentration, College going reproductive age women, Berhampore.

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INTRODUCTION

In the period of diversified and progressed societies, anemia prevails as a global serious public health concern, especially in countries with limited capital. Anemia is an acute worldwide health issue characterized by an inadequate number of erythrocytes and hemoglobin levels. The incidence of anemia among various categories of people in India is increasing day by day and the reproductive age of women remains on the front page in this case.[1,2] The causes of anemia are multifaceted, ranging from genetic factors to nutritional deficiencies, such as a lack of iron, vitamins, and folate.[3] In conformity with the World Health Organization (WHO), 29.9% of reproductive-age women globally suffered from anemia in 2019[1]. According to the National Family Health Survey 4 (NFHS 4) report,[4] over 63% of women in West Bengal suffer from anemia, underscoring the crucial need for enhanced nutritional strategies and healthcare interventions. For instance, anemia can often be managed with dietary changes including enhancing dietary iron intake, fortifying foods, and iron supplements, sometimes injections, and improving access to healthcare services to manage this prevalent condition effectively.[5] Iron requirements in women are indeed influenced by various stages of life and physiological conditions. Hormonal fluctuations during puberty, menstrual cycles, pregnancy, breastfeeding, and menopause can affect iron metabolism and increase the risk of anemia.[6] Factors such as menstrual bleeding, use of oral contraceptives, intrauterine devices, childbirth, uterine fibroids, urinary tract infections, dietary habits, *etc*. play significant roles in reducing iron levels.[7] In rural areas, the most frequent cause of anemia is poverty-stricken family, lack of education, poor healthcare services, improper hygienic conditions, and malnutrition.[8-10] So, sociodemographic factors such as age, academics, socioeconomic background, geographic area, region, ethnicity, smoking, and drinking habits are accompanied by the prevalence of anemia.

Berhampore is a renowned town in the Murshidabad district

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of West Bengal and among the total population, 51.3% of females as per Census India 2011.[11] The overall literacy rate is higher but the female literacy rate is lower than men. Several numbers of prevalence studies on anemia have been done on various types of age groups and populations.[12,13] Berhampore Girls' College is one of the prestigious colleges dedicated to women's education, located in the heart of Berhampore town. This institute comprises students from diverse geographical backgrounds, surrounding both rural and urban areas of Murshidabad and neighboring districts. But in Berhampore town, so far literature surveyed, the evidence of prevalence study on anemia has not been reported till now. The lack of existing data on anemia in this region, such a study could fill a significant gap in public health knowledge and potentially guide us for future interventions. So, this study could provide valuable insights into the prevalence and the contributing factors of anemia in reproductive-age women, including socio-demographic issues, lifestyle, food habits, and physical and anthropometric parameters with a cross-sectional study method.

MATERIALS AND METHODS

Martin's anthropometer, Wright's peak flow meter, Medi-line Advance Stethoscope, Sphygmomanometer, and Drabkin's Solution (Arkray) were used.

Selection of Subjects

The college-going students were selected ensuring a diverse yet controlled sampling by including female students from Berhampore Girls' College (Berhampore, Murshidabad, West Bengal, India-742101, 24.0912° N, 88.2538° E) between the age of 18 to 23 years. They are mostly from the nearby areas like Berhampore, Beldanga, Krishnapur, Lalgola, Tehatta, Kaliaganj, Kandi, Hariharpara, Domkol, Bhagwangola, Jalangi, Kazipara, and Amtala. A comprehensive set of parameters was taken from the participants including anthropometric parameters, vital signs, and hematological parameters with informed written consent. Individuals taking any type of drugs, and having major health issues - mainly cardiovascular, respiratory, renal, endocrinal, reproductive, hematological, or metabolic disorders, smokers, alcoholics, and pregnant ones were excluded to minimize confounding variables. All the possible measures were taken to maintain the participants' privacy and data confidentiality.

The study was conducted as per the study design as depicted in Figure 1. According to the Hb concentration (gm/dl), the total volunteers (18–23 years) were divided into two major categories: healthy individuals ([Hb] > 11 gm/dl) and anemic individuals ([Hb] < 11 gm/dl). As per the guidelines of Indian Council of Medical Research (ICMR) and National Cancer Institute (NCI), the anemic individuals were divided into 4 categories: mild anemic ([Hb] = 10.9–10 gm/dl), moderate anemic ([Hb] = 9.9–8 gm/dl), severe anemic ([Hb] = 7.9–6.5 gm/dl) and life-threatening anemic ([Hb] < 6.5 gm/dl)[14,15].

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Determination of Sample Size

As per NFHS-4, 58.1% of reproductive-age women were anemic in Murshidabad District, West Bengal.[16,17] Based on prevalence $p = 0.581$, 95% confidence interval $z = 1.96$; Relative error (e) = 0.05 and population (N) = 150. As per the formula, the final sample size was approx. 107.

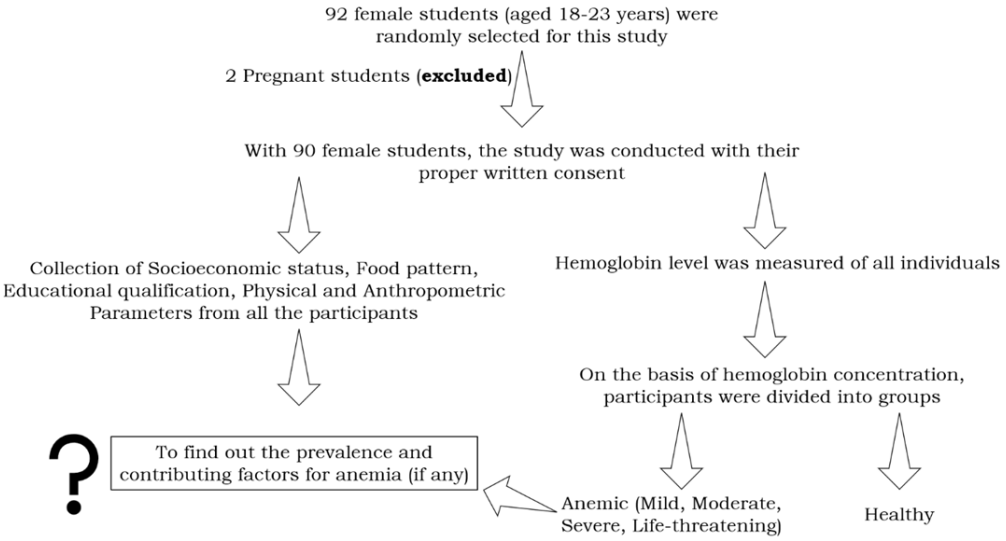

Figure 1: Flowchart of the study design

Collection of Variables

The studied population was asked several questions to carry out this study. In this section, the studied population was asked about their age, residence, parent's educational qualification, economic status (monthly), daily food consumption, menstrual history, physical activity, and lifestyle. After collecting all the data, the anthropometric parameters, physical parameters, and biochemical parameters were measured.

Measurements of Anthropometric parameters

The anthropometric parameters were done through the standard techniques in a stature position (*i.e.* upright position) using Martin's anthropometer.[18,19] Body weight was noted (with a lightly-clothed and upright position) with an analog weighing machine and the scale was set to zero "0" before every single measurement. Body mass index (BMI) was computed according to the following equation:[20,21]

$$BMI\ (kg/m^2): Weight\ (kg)/height^2\ (m^2)$$

To find out the relationship between obesity and anemia, mid-upper arm circumference (MUAC), hip circumference (HC), waist circumference (WC), conicity index (CI), and abdominal volume index (AVI) were measured.

The MUAC, HC, and WC were measured using a stretchy measuring tape by following the standard protocol.[21-23] The waist-hip ratio (WHR) was calculated by following the equation:[20,21]

$$WHR = WC\ (cm)/HC\ (cm)$$

CI was measured according to the following equation:[24,25]

$$CI = WC\ (m) / [0.109 \times \sqrt{\{Weight\ (kg) / Height\ (m)\}}]$$

AVI was measured according to the following equation:[26,27]

$$AVI = [2 \times WC\ (cm)^2 + 0.7 \times \{WC\ (cm) - HC\ cm)^2\}] / 1000$$

Collection of Vital Signs

The systolic and diastolic blood pressure (SBP; DBP) of the subjects were obtained by the auscultatory method at a sitting position in resting condition.[28,29] The heart rate of the subjects was obtained by using the simple Watch method in resting condition.[30,31] The respiratory rate was measured at rest manually.[32] The peak expiratory flow rate (PEFR) was measured at the upright position using Mini Wright's peak flow meter as per the standard protocol.[33,34]

Collection of Blood

The study individuals gave their consent and about 1-mL of venous blood was collected by phlebotomy technique after taking 20 to 30 minutes rest at a sitting posture (Ethical Clearance Ref. No. PHY/IHEC/RH/Certificate/01/22). The blood was collected in a heparinized vial from the volunteers to perform the hemoglobin estimation by Drabkin's method.[35,36]

Statistical Analysis

The statistical analysis was achieved considering a 95% confidence level. Descriptive statistics, Students' t-test, ANOVA, and Pearson's correlation were employed with a significant level at $p < 0.05$. The data were evaluated with Microsoft Excel Office 2019.

RESULTS

We observed that out of a total 90 subjects, 75.55% were anemic, and the percentages of the mild, moderate, severe and life-threatening anemic subjects were respectively 9, 37, 22, and 8% (Figure 2).

Another observation is that, among all the individuals, 24 (26.66%) residing in urban areas and 66 (73.33%) in rural areas (Urban:Rural = 1:2.75). Notably, the prevalence of anemia was disproportionately higher in rural areas, affecting 86.36% of the population compared with the urban ones (45.83%) (Figure 3).

The literacy rate of parents among rural individuals was low, with 12% having education below the Madhyamik level and 21% having completed Madhyamik. Parent education is one of the reasons for the incidence of anemia, but in this cohort, no such significant relation was found between the occurrence of anemia and parent's education (Figures 4a and b). Figures 5a and b depict that, with the betterment of the economic state, the frequency of anemia decreased. Notably, 42.4% of this rural population has a monthly family income of ₹10,000 or less. The incidence of anemia was increased with the decrease in consumption of dietary iron in this cohort (Figures 6a and b). The average daily iron intake from food is about 10.67 ± 3.81 mg in the rural population, compared to 13.05 ± 4.94 mg in the urban population. The intake of fruits and animal-based foods, such as eggs, meat, and fish was less among the subjects.

The average menstrual duration of this cohort was approximately 4 to 5 days. There are no reported cases of oligomenorrhea or amenorrhea, but very few menorrhagia, hypomenorrhea, and dysmenorrhea are present in both healthy and anemic individuals. Anemic individuals commonly exhibit symptoms such as weakness and lethargy.

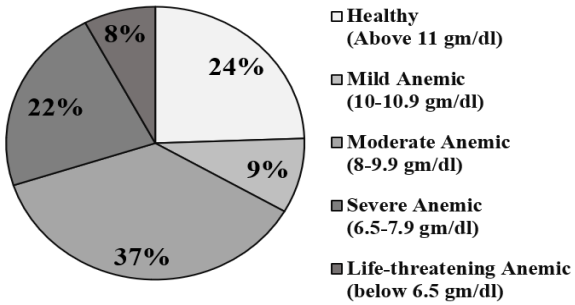

Figure 2: The distribution of all individuals according to the hemoglobin concentration

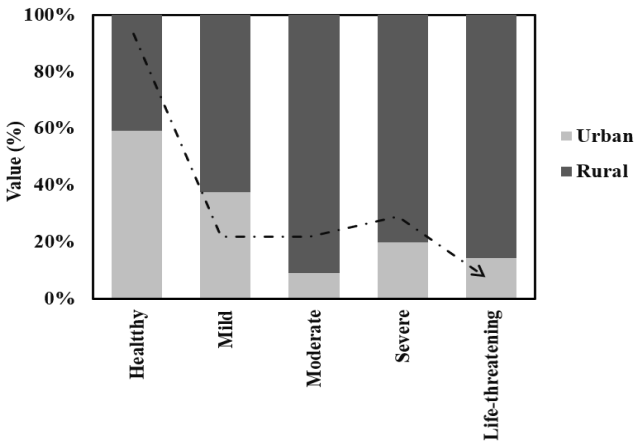

Figure 3: The type of locality among different groups. The results are expressed in percentage values

Lifestyle factors, including skipping meals (breakfast, lunch, tiffin, dinner) and regular physical activities (like yoga, dance, swimming, free-hand exercise, lifting, karate, etc.), do not influence the frequency of anemia.

There was no such correlation (Figure 7) found with all the anthropometric parameters and physical parameters with respect to Hb concentration. The mean, median, standard deviation (SD), and upper and lower limits are presented in a tabulated format (Table 1).

DISCUSSION

The prevalence of anemia is increasing globally day by day specifically in women of reproductive age. In the case of anemia prevalence, India endures at the forefront on a global scale as it is a developing country. According to WHO projections, 539 million non-pregnant reproductive-age women (around half a billion) were affected by anemia[2,37].

In West Bengal, the prevalence of anemia is quite high; according to NFHS-4 (2015–2016), 53.6% of women of reproductive age had anemia, while NFHS-5 (2019–2021) reported a prevalence rate of 71.7% [38]. This current study exhibited the prevalence of anemia is 75.55% among college-going women of Berhampore Girls' College.

There are various contributing factors which was allied with anemia among women of reproductive age, such as socio-demographic issues, family education, economic background, lifestyle, food habits, etc.[10,39,40] A large proportion of this cohort exhibits anemia, with a significant prevalence observed among individuals residing in rural areas. A cross-sectional study introduced that 70.8% of reproductive-age women were anemic, and belong to rural areas in West Bengal.[41] Another study reported that the prevalence of anemia was 57.2% in rural areas compared with the urban areas after experimenting upon 1027 pregnant women[42]. Our study also supports the fact that socio-demography is one of the contributing factors to the severity of anemia, as 73.33% (n = 66) were residing in rural areas (from the overall population) and among the rural population, 86.36% (n = 57) were anemic. Therefore, it can be said that socio-demographic background plays a vital role in the severity of anemia (Figure 3). Our findings also support the study of Sharma *et al*., (2024), who reported a similar prevalence of anemia among reproductive-age women in rural areas of Uttar Pradesh.[43]

Parent's proper education plays a key role in the reduction of anemic individuals across the family members.[44,45] Several studies constantly found that the rate of anemia prevalence is inversely proportional to the higher educational qualification.[45] In this study, a minute change has been noticed in the case of parents' education with the prevalence of anemia, *i.e*., the development of anemia is very slightly

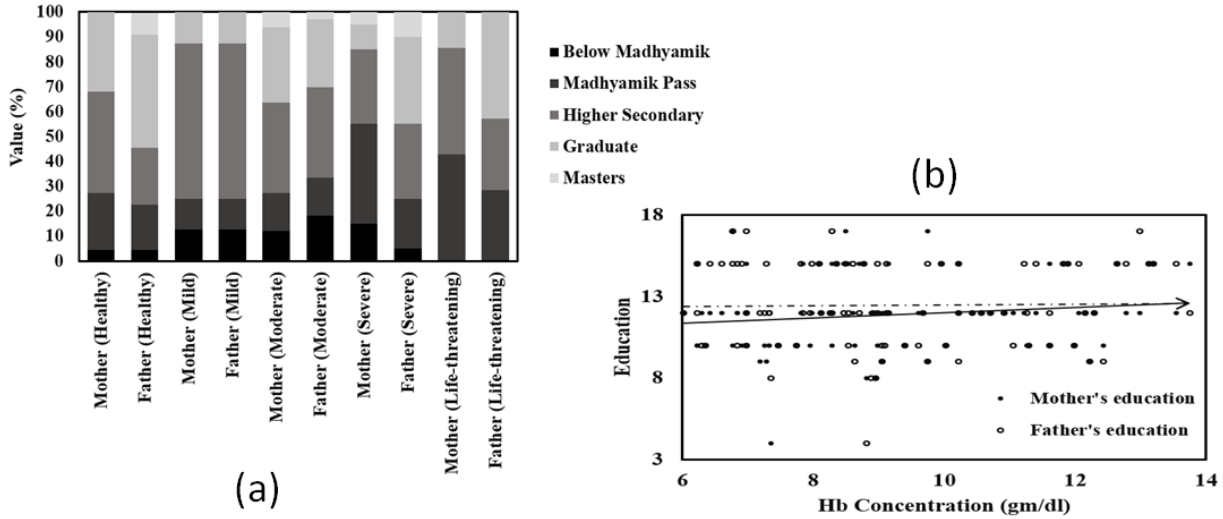

Figure 4: (a) The stacked bar graph represents the educational qualification of parents among the groups. The results are expressed in percentage values. (b) The scatter plot of educational qualification of parents against hemoglobin concentration

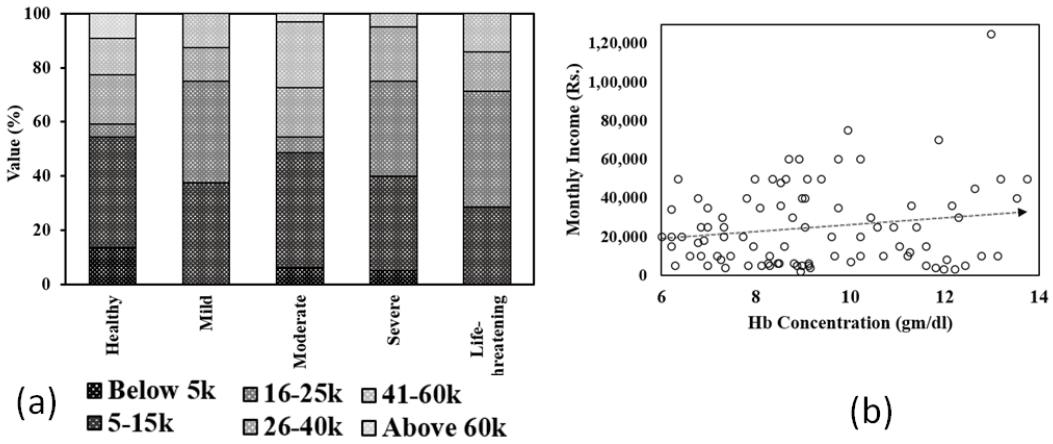

Figure 5: (a) The stacked bar graph represents the monthly family income among the groups. The results are expressed in percentage values. (b) The scatter plot of monthly family income against hemoglobin concentration

decreased with the upgradation of parent's educational qualification (Figure 4).

Gross family income contributes conclusively to the occurrence of anemia. The poorest sectors are more likely to suffer from anemia than those from the wealthiest sectors on account of inadequate access to nutritious food, struggle to afford a balanced diet, and sometimes have to reduce or skip meals.[2,46,47] Economically backward people have a limited understanding of foods rich in vitamins and minerals and their access to healthcare is inadequate.[2,48] As the economic state improves, the prevalence of anemia decreases (Figures 5a and b). Notably, 42.4% of the anemic population in rural areas earn ₹10,000 or less per month, highlighting a significant economic disproportion contributing to health issues. Moreover, women from lower economic backgrounds may face a lack of basic hygiene resources, like clean water and sanitation, enhancing the risk of infectious diseases that can accelerate the risk of anemia.[2,46]

The emphasized area for the prevalence of anemia is women's diet and deficiency of micronutrients in their diet specifically iron.[49] The absorption of iron involves heme iron and non-heme iron. Heme iron mostly comes from animal sources and non-heme iron mostly comes from plant sources and supplements.[50] Heme iron present in beef, poultry, meats, fish, prawn, and seafood is more readily absorbed in our body and has a greater bioavailability than non-heme iron which is primarily sourced from plant-based foods like cereals, pulses, vegetables, beans, resins, nuts, dark chocolate, cherries, legumes, spinach and fortified grains.[51,52] In this study, the daily consumption of iron-containing foods decreases the development of anemia (Figure 6). In the rural anemic population, the daily iron consumption is slightly lower (10.67 mg/day) than in the urban population (13.05 mg/day). Most of the nutrients are possibly lost during the extensive cooking in typical Indian cuisine.[51,53]

In the case of anthropometric parameters' relation with the occurrence of anemia, some researchers showed no association between anemia and the anthropometric indicators by surveying 168 school-going children (6–12 years).[54] A group of researchers established that there is no relation between anthropometric parameters and hematological parameters, specifically hemoglobin by

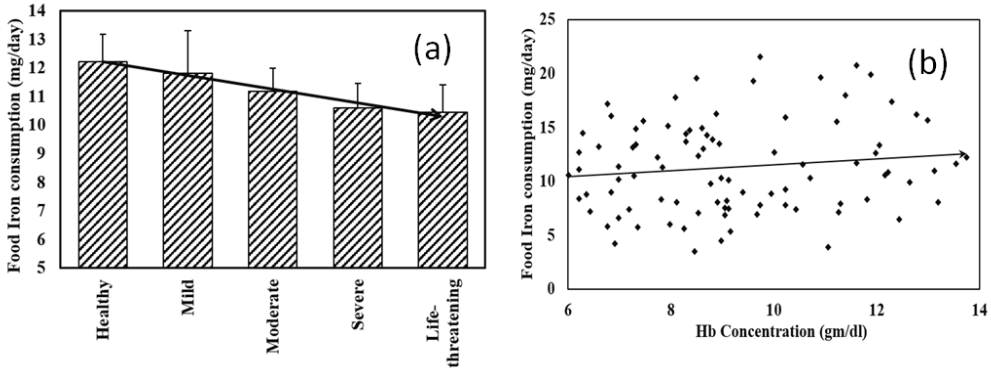

Figure 6: (a) The bar diagram represents the consumption of iron from foods (plant and animal sources) per day among the groups. The results are expressed in mean ± SEM values. (b) The scatter plot of the consumption of iron from foods against the hemoglobin concentration

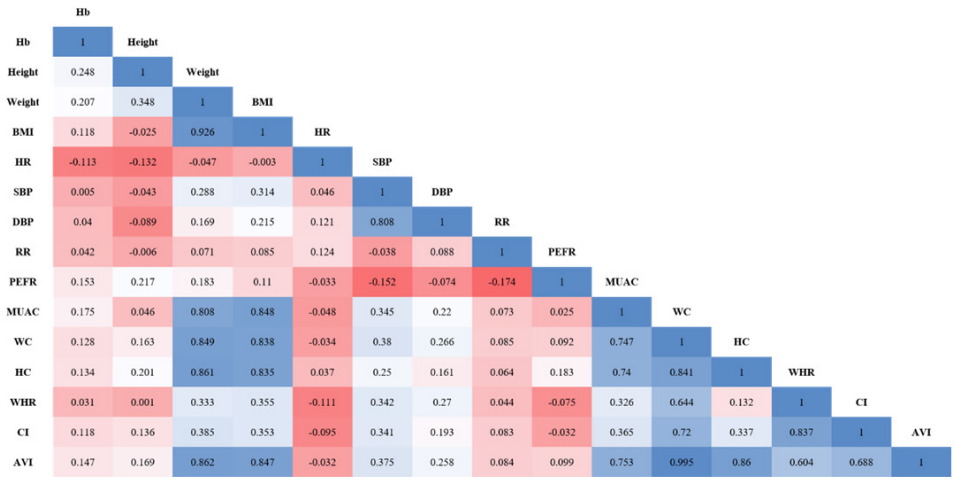

Figure 7: Heatmap of Pearson correlation coefficient matrix with different physical and anthropometric parameters among different groups with their r values (95% CI)

Table 1: Values of recorded parameters with their descriptive statistics

Variables	*Mean ± SD*	*Median (Range)*
Hemoglobin (gm/dl)	9.24 ± 2.06	8.92 (6.01–13.74)
Body height (m)	1.56 ± 0.05	1.55 (1.46–1.74)
Body weight (kg)	51.38 ± 9.26	52 (83–34)
Body mass index (kg/m^2)	20.94 ± 3.79	20.69 (14.58–34.32)
Heart rate (beats/min)	88.26 ± 11.04	88 (62–122)
Systolic blood pressure (mmHg)	112.93 ± 5.55	112 (102–130)
Diastolic blood pressure (mmHg)	75.26 ± 4.45	76 (60–88)
Respiratory rate (breaths/min)	28.11 ± 7.30	28 (16–48)
Peak expiratory flow rate (l/min)	346.77 ± 61.50	350 (160–470)
Mid-upper arm circumference (cm)	25.68 ± 3.35	25.4 (20.0–39.4)
Waist circumference (cm)	78.84 ± 10.06	80.4 (53.4–104.0)
Hip circumference (cm)	94.26 ± 9.29	94.7 (71.0–121.2)
Waist-hip ratio	0.83 ± 0.05	0.83 (0.69–1.0)
Conicity index	1.25 ± 0.07	1.26 (1.03–1.42)
Abdominal volume index	12.82 ± 3.14	13.04 (6.02–21.83)

conducting a study on 81 subjects (including both men and women), 18 to 22 years.[55] A study was conducted with 126 pregnant women and they did not find any significant correlation of PEFR with the incidence of anemia.[56] Being overweight and obese does not interlink with the prevalence of anemia, but underweight women are more likely to be anemic, as stated by a group of researchers in Bangladesh, surveyed 5680 reproductive-age women.[57] Our study also supports this factor that there is no such significant correlation observed between anthropometric and physical parameters with the severity of anemia. Moreover, these anthropometric and physical variables, such as height, weight, BMI, conicity index, abdominal volume index, WC, HC, WHR, MUAC, heart rate, systolic & diastolic blood pressure, respiratory rate, and PEFR do not affect in the development of anemia in this cohort.

This study concludes that the prevalence of anemia is higher in college-going reproductive-age women residing in rural areas due to their poor socio-economic status, food intake pattern, and poor lifestyle. Economic instability restricts the ability to purchase nutritious foods, and low parental education levels contribute to a lack of awareness about balanced diets. Dietary habits influenced by economic constraints and cultural practices result in limited consumption of iron-rich and micronutrient-containing foods, leading to iron deficiency and anemia. Additionally, the rural setting limits the availability of diverse and quality food substances, contributing to the rising prevalence of anemia in this study area. In the future, this comprehensive study on the prevalence of anemia will act as a model and pave the way for further advanced research on this population.

The prevalence of anemia may be managed by lifestyle, parent education with proper diet. If the contributing factors of anemia are addressed in the early stage, then by improving the lifestyle pattern and living a healthy life, the prevalence can be reduced. The association of these confounding factors with anemia and other comorbidities will be explored in the near future. This study was conducted on a limited population and comprised only college-going non-pregnant reproductive-age women. The level of micronutrients (iron, folate, vitamin B_{12}) was not assessed at the hematological level to find out the original cause of anemia. To draw the significant relation between the contributing factors and the development of anemia, we need to proceed with the study in a large population.

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PEER-REVIEWED CERTIFICATION

During the review of this manuscript, a double-blind peer-review policy has been followed. The author(s) of this manuscript received review comments from a minimum of two peer-reviewers. Author(s) submitted revised manuscript as per the comments of the assigned reviewers. On the basis of revision(s) done by the author(s) and compliance to the Reviewers' comments on the manuscript, Editor(s) has approved the revised manuscript for final publication.