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Prevalence and Association of Haemoglobin and Body Mass Index of Young Adult Girls – A Cross-sectional Institutional Study

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ABSTRACT: Worldwide, anaemia is the most prevalent and persistent nutritional problem. Especially in developing countries like India, its most common in college going students. Low haemoglobin concentration and abnormal body mass index (BMI) have detrimental effects on health. The study aimed to investigate the association between haemoglobin levels and BMI among undergraduate young adult girl students. A cross-sectional institution-based study was conducted among 120 undergraduate young adult girl students. Results showed that majority (32.50%) of them were underweight. And 27.50 per cent were having normal weight. Pre-obese were 7.50 per cent and 15.83 per cent belonged to obesity class I and in obesity class II were 16.67 per cent. The majority of students had normal haemoglobin levels. However, there were 10 per cent mild and 20 per cent moderate anaemic students. A significant association was found between BMI and haemoglobin levels, revealing a higher prevalence of anaemia within the underweight category.

Keywords: Iron deficiency anaemia, body mass index, haemoglobin.

INTRODUCTION

The World Health Organization (WHO) has estimated that anaemia affects around 56 per cent of the global population, with prevalence rates varying from 35 per cent to 75 per cent across different geographical regions. Among young adults worldwide, anaemia affects approximately 30 per cent to 55 per cent of individuals. This condition remains a significant public health challenge globally, particularly impacting developing countries like India. Iron deficiency anaemia is especially prevalent among adolescent girls during their growth phases and among college-going populations (Sinha *et al.*, 2012).

There are several factors that contribute to anaemia, including dietary iron deficiency, parasitic infestations, infectious diseases such as malaria, deficiencies in essential micronutrients like folate, vitamin B12, and vitamin A, and inherited conditions affecting red blood cells (RBCs) like thalassemia. Young adults, especially females, are increasingly vulnerable to anaemia due to increased iron requirements during puberty, excessive menstrual losses (associated with conditions like polymenorrhea and menorrhagia), inadequate intake of dietary iron (particularly from animal sources) and poor dietary habits (Estima *et al.,* 2009). Iron deficiency resulting in low haemoglobin (Hb) concentrations leads to fatigue, reduced work capacity, impaired cognition, and consequently, poor academic performance among students (Halterman *et al.,* 2001).

Iron deficiency anaemia is prevalent among young adults, and abnormal body mass index (BMI) further increases their susceptibility to this condition. Being underweight can lead to iron depletion and raise the risk of iron deficiency anaemia. Conversely, overweight or obese individuals often experience disrupted iron levels, contributing to an increased tendency toward anaemia (Moayeri *et al.,* 2006; Aigner *et al.,* 2014).

Changes in lifestyle and behaviour, such as increased consumption of readily available fast foods, inadequate and inappropriate dietary habits, and a sedentary lifestyle, makes individual susceptible to nutritional disorders such as being underweight, obese, and anaemia (Singh *et al.,* 2018).

The association between anaemia and BMI serves as a measure of nutritional status in adults. Therefore, the present study aimed to investigate the association between haemoglobin levels and BMI among undergraduate students.

MATERIAL AND METHODS

This cross-sectional study was conducted in the year 2024. All the first year undergraduate girl students who were residing in ladies hostel were selected for the study. Permission was obtained from the ethical committee of the University of Agricultural Sciences, Dharwad.

Exclusion criteria: Students with chronic illness and who were on supplements and students who refused to participate in the study.

Inclusion Criteria: Students willing to give informed consent/assent, age between 18 and 21 years, under no history of any medications, students who were willing to give blood sample for estimating haemoglobin and students staying in hostel were taken for study.

Informed verbal and written consent was obtained from all participants upon explaining the objectives and methodology of the study, ensuring ethics and confidentiality.

The anthropometric measurements viz., height and weight were measured as per the guidelines suggested by ICMR standards. The height was measured by using a height scale nearest to 0.1 cm. A portable personal weighing scale was used to measure the weight in kilograms nearest to 0.5 kg, with ordinary casual clothing and without shoes.

Body mass index: The anthropometric measurements of the adolescent girls were used for calculating the body mass index which was expressed as ratio of weight (kg) to height in metre square.

$$\text{BMI} = \frac{\text{Weight (kg)}}{(\text{Height})\,(\text{m})^2}$$

Further, individuals were classified into different BMI categories based on the classification provided by WHO (2003) for adolescent girls. The BMI classifications are as follows:

— Below 18.5: Underweight
— 18.5–24.9: Normal weight
— 25.0–29.9: Pre-obesity
— 30.0–34.9: Obesity class I
— 35.0–39.9: Obesity class II
— Above 40: Obesity class III

For haemoglobin estimation intravenous blood was taken by inserting a needle into a vein in the arm. The blood samples were collected in vacutainer tubes (lavender/ purple colour tubes) by the technician. Blood samples collected were sent to the Neuberg Anand Diagnostics Laboratory for haemoglobin assessment.

The World Health Organization (WHO) has classified anaemia into four groups based on haemoglobin levels. These categories are:

— **Normal**: >12 g/dl.
— **Mild**: 11 to 11.9 g/dl.
— **Moderate**: 8.0 to10.9 g/dl.
— **Severe**: <8.0 g/dl.

Data analysis for association with haemoglobin and body mass index was done using SPSS software version 17.0

RESULTS AND DISCUSSION

The Table 1 shows the distribution of young adult girls based on their Body Mass Index (BMI) classifications, with a sample size of 120 students. Among these students, 39 (32.50%) were underweight, having a BMI of less than 18.5. A total of 33 students (27.50%) were inthe normal weight range, with BMIs between 18.5 and 24.9. Nine students (7.50%) were identified as pre-obese, with BMI ranging from 25.0 to 29.9. And 19 students (15.83%) were categorized as having obesity class I, with BMI between 30.0 and 34.9, while 20 students (16.67%) were in obesity class II, with BMI between 35.0 and 39.9. Notably, there were no students under obesity class III (BMI - above 40). This distribution highlighted the varying BMI categories among the young adult girls, with a significant proportion being underweight and a considerable number falling into different classes of obesity.

The Table 2 shows the distribution of young adult girls based on their haemoglobin levels, with a total of 120 participants. The majority of the students, 83 (69.17%), had normal haemoglobin levels, defined as greater than 12 g/dl. A smaller portion, 12 students (10%), exhibited mild anaemia with haemoglobin levels ranging from 11 to 11.9 g/dl. Moderate anaemia, characterized by haemoglobin levels between 8.0 and 10.9 g/dl, was found in 24 students (20%). Only 1 student (0.83%) was classified as having severe anaemia, with a haemoglobin level below 8.0 g/dl. This distribution highlighted that most young adult girls in the study maintained normal haemoglobin levels, though a significant minority experienced varying degrees of anaemia.

The Table 3 shows the association between haemoglobin levels and Body Mass Index (BMI) among young adult girls. Based on haemoglobin levels, they were categorized as either anaemic or non-anaemic. The BMI is classified as underweight (below 18.5), normal weight (18.5-24.9), pre-obesity (25.0-29.9), obesity class I (30.0-34.9), obesity class II (35.0-39.9), and obesity class III (above 40). Among the anaemic students, 27 (22.5%) were underweight. However only 12 (10.0%) of them were non-anaemic students. In the normal weight category, there were only 8 students (6.7%) who were having anaemia. And 30 non-anaemic students (25.0%) were normal BMI category. In the pre-obesity category, there was only 1 anaemic student (0.8%) and 21 non-anaemic students (17.5%). For obesity class I, again there was only 1 anaemic student (0.8%) and 10 non-anaemic students (8.3%) were recorded. There were no anaemic students in obesity class II, but 9 non-anaemic students (7.5%) were in this category. There was only 1 non-anaemic student (0.8%) in obesity class III. There was no anaemic student who belonged to category obesity class III. Overall, the Table 3 indicated a significant association between BMI and haemoglobin levels. It was observed that there was higher prevalence of anaemia in the underweight category and a higher prevalence of non-anaemia in the normal weight and pre-obesity categories.

Anemia and an unfeasable body mass index (BMI) during childhood and adolescence are linked to negative outcomes. There is a increased risk of iron deficiency anemia in adolescents, which may be aggravate by an unhealthy BMI. As a result, these individuals are more likely to experience reduced work capacity, poor academic performance, increased susceptibility to infections, and a higher long-term morbidity and mortality rate (Khan *et al.* 2018). Bano *et al.* (2012) reported that a majority (81.8%) of anaemic students were undernourished based on their BMI. Additionally, Pandey and Singh (2013) reported that the prevalence of anemia was 60 per cent among underweight students, 27.5 per cent among those with normal BMI and 12.5 per cent were overweight students.The study indicates a significant association between anemia and BMI. Multiple studies have also demonstrated this relationship. BMI is commonly used as an indicator for measuring underweight and obesity (Laghari *et al.,* 2017).

In this study, only young adult girls who were staying in the hostel were included. Hence, the food frequency was same for them. Details were taken from the hostel. A nutritious breakfast comprise of carbohydrates, proteins, fats, fibre, vitamins, and minerals, particularly iron and vitamin C, crucial for sustained energy release. It was observed that skipping breakfast was prevalent among hostel students in various studies (Shill *et al.* 2014). Reasons cited for skipping breakfast were late awakening, lack of morning hunger or dissatisfaction with the available food options.

In hostels, frequency of fruits given is less. In this study, hostel students were given banana only twice a week. And no other fruit was given and consumption of green leafy vegetables (GLVs) is also less. Spinach, Dill and amaranth are the GLVs (weekly) used in hostel. Frequency of purchasing fruits was less in the students as fruits were not readily available and it mainly depends on the socio-economic status. Fruits and vegetables are good source of vitamin C and vitamin C is known to enhance iron absorption. The lack of fruit and vegetable intake in the diet is considered a contributing factor to poor health status, as noted in studies such as Moy *et al.* (2009).

Non – vegetarian food was provided twice a month. And only some of them consumed non vegetarian food. Non vegetarian food is the source of heam iron which is absorbed more in the body than non –heam iron which is sourced from plants.

Frequency of purchase of snacks largely depends on the socio-economic conditions potentially leading to skipping the meals in hostel. Poor eating habits, including meal skipping, frequent snacking, and consumption of fast food, are significant public health concerns among university students. These behaviours predispose them to dietary deficiencies, as highlighted by Kurubaran *et al.* (2012). Fast food is often preferred by students due to its appealing flavour, aroma, and taste, as noted in studies such as Aziz *et al.* (2017).

The mean daily iron loss through menstruation over a 28-day cycle averages about 0.56 mg/day (Chandra *et al.,* 2017). Despite simple diagnosis, anaemia often goes unrecognized for prolonged period due to its nonspecific clinical symptoms and insufficient testing. Anaemia is linked with reduced work capacity and enduring impacts on learning, cognitive function, attention, behaviour and growth. Early detection of the disease and its contributing factors is crucial step towards effective management (Sam and Udaykumar 2017).

In the hostel, tea or coffee is served twice a day *i.e.*, immediately after breakfast and after snacks. As a result, students typically consume tea or coffee right after these meals and snacks. This shows the lack of knowledge regarding inhibitory factors such polyphenols and tannins present in tea/coffee. Patimah *et al.* (2016) concluded that poor dietary knowledge has been linked to iron deficiency anaemia (IDA). Additionally, it has been observed that consuming tea with meals can hinder iron absorption in the body, potentially contributing to lower haemoglobin levels (Appanah *et al.,* 2009).

Nutritional deficiencies which contribute to anaemia could have significant health implications for future professionals in India. Therefore, further research is needed *i.e.,* which may include detailed studies on various types of anaemia and longitudinal assessments to track year-wise prevalence among students. Such research would be crucial in designing effective intervention programs aimed at promoting healthier outcomes and potentially translating into healthier adults in the future.

Table 1: Distribution of young adult girls based on body mass index (BMI) classification.

BMI	Number of students (n = 120)
<18.5 (Underweight)	39 (32.50)
18.5 – 24.9 (Normal weight)	33 (27.50)
>25.0 – 29.9 (Pre-obesity)	9 (7.50)
> 30.0 – 34.9 (Obesity class I)	19 (15.83)
35.0 – 39.9 (Obesity class II)	20 (16.67)
Above 40 (Obesity class III)	0 (0)
Total	120

Values in parentheses indicate percentage

Table 2: Distribution of young adults (girls) based on haemoglobin classification.

Haemoglobin level (g/dl)	Number of students (n = 120)
Normal (>12)	83 (69.17%)
Mild (11 -11.9)	12 (10 %)
Moderate (8.0 – 10.9)	24 (20 %)
Severe (<8.0)	1 (0. 83 %)
Total	120

Values in parentheses indicate percentage

Table 3: Association of haemoglobin to BMI in young adults (girls) classified as anaemic and non-anaemic.

BMI	Anemic students	Non-anemic students	Total	Chi square
Below 18.5 (Underweight)	27 (22.5)	12 (10.0)	39 (32.5)	42.691**
18.5–24.9 (Normal weight)	8 (6.7)	30 (25.0)	38 (31.7)	
25.0–29.9 (Pre-obesity)	1 (0.8)	21 (17.5)	22 (18.3)	
30.0–34.9 (Obesity class I)	1 (0.8)	10 (8.3)	11 (9.2)	
35.0–39.9 (Obesity class II)	0 (0)	9 (7.5)	9 (7.5)	
Above 40 (Obesity class III)	0 (0)	1 (0.8)	1 (0.8)	
Total	37 (30.8)	83 (69.5)	120 (100)	

** Significance at 0.01%; Values in parentheses indicate percentage

CONCLUSIONS

In this study, the majority of anaemic students were underweight due to the inadequate iron consumption. And there was significant association between the anaemia and body mass index. In India, anaemia is predominantly caused by insufficient dietary intake and poor iron absorption which affects over 80 per cent of women due to increased bodily demands. To address iron deficiency anaemia (IDA) among girls, food-based strategies should be prioritized. These strategies can include consumer education aimed at diversifying diets to include iron-rich foods and fruits containing Vitamin C, which enhances iron absorption. Also emphasizing specific issues such as iron hindering factors present in foods and the benefits of iron enhancers like Vitamin C. Addressing physiological, socioeconomic, and behavioural factors is crucial. It's essential to promote comprehensive nutritional knowledge about anaemia by making nutritional education sessions mandatory.

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Conflict of Interest. None.

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