

RESEARCH ARTICLE

Hemoglobin concentration in relation to body mass index among undergraduate medical students – A cross-sectional institutional study

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ABSTRACT

Background: The result of the association between anemia and body mass index (BMI), a measure of the nutritional status of adults, has been inconsistent. There is a paucity of data correlating hemoglobin with BMI in our context. Abnormal BMI is associated with altered hemoglobin concentrations. **Aim and Objective:** The present study was done to find out the correlation of hemoglobin level with abnormal BMI in undergraduate medical students. **Materials and Methods:** A cross-sectional institution-based study was performed in 167 undergraduate medical students. BMI was calculated by Quetlet's index and hemoglobin concentration was estimated by Sahli's method. Correlation between hemoglobin concentration and BMI was assessed by Pearson's correlation coefficient. **Results:** The mean hemoglobin levels in females were statistically lower than males (10.7128 ± 1.9165 vs. 13.7321 ± 1.7072 , $P < 0.0001$). On correlating BMI with hemoglobin, Pearson's coefficient was -0.05 with $P = 0.481$, implying that there was no perfect correlation. On comparing the three groups of BMI, it was seen that there was a statistically significant difference in the mean hemoglobin levels of the three groups (11.2167 ± 2.075 vs. 12.6642 ± 2.302 vs. 11.7844 ± 2.487 , $P = 0.028$). It was seen that the hemoglobin levels in underweight and overweight group were lower as compared to normal BMI group. **Conclusion:** Abnormal BMI, whether underweight or overweight/obese, increases the risk of anemia. There is a negative correlation of hemoglobin concentration with BMI among individuals with abnormal BMI.

KEY WORDS: Anemia; Body Mass Index; Medical Students

INTRODUCTION

Anemia remains one of the major public health challenges with global impacts, especially in developing countries like India. Iron deficiency anemia is most common among growing adolescents and college-going students.^[1] Low hemoglobin concentration and abnormal body mass index (BMI) adversely affect the health of people, subsequently increasing morbidity and mortality among them.

Low hemoglobin concentration as a result of iron deficiency causes fatigue and reduces the capacity to perform work, impaired cognition and thus results in poor academic performance among students.^[2] On the other hand, being overweight or obese is considered a major risk factor for early onset of chronic diseases among adults, and also hampers the academic performance of students to a great extent.^[3]

Adolescents are at increased risk of iron deficiency and thus are vulnerable to anemia.^[4] Abnormal BMI among them further predisposes them to the risk of developing anemia. Underweight leads to iron depletion and increase the risk of iron deficiency anemia. Overweight or obese individuals have deranged iron status and thus increased tendency to be anemic.^[5,6]

Medical fraternity is among the literate and well-informed sector of society. Medical students at a medical college are

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supposed to have thorough knowledge about the benefits of a healthy diet and lifestyle. However, due to the stress of the curriculum and considerable changes in lifestyle and behavior, increased consumption of easily and cheaply available fast foods, inadequate and inappropriate dietary habits, and mechanical job profile, they become susceptible to nutritional disorders, including obesity and anemia.^[7]

The result of the association between anemia and BMI, a measure of nutritional status of adults, has been inconsistent. There is a paucity of data correlating hemoglobin with BMI in our context. Thus, the present study was done to find out the correlation of hemoglobin level with BMI in undergraduate medical students.

MATERIALS AND METHODS

This cross-sectional study was conducted in 200 1st year medical students of SKIMS Medical College and Hospital in the Department of Physiology, Srinagar, from December 1, 2018, to July 1, 2019, after obtaining permission from the ethical committee of the college.

Exclusion Criteria

The following criteria were excluded from the study:

Students with history of bleeding disorders
Students who refused to participate in the study
Students with eating disorders.

After written consent, the volunteer students were asked to come to the department for an estimation of their hemoglobin concentration and anthropometric measurements.

Hemoglobin level was estimated by Sahli's acid hematin method. The hemoglobin tube was filled with N/10 hydrochloric acid up to 2 g % marking. This graduated tube was placed in Sahli's hemoglobinometer (comparator with brown glass). Capillary blood was collected by the finger-prick method, using 22 G disposable needles, and blood was drawn into Sahli's pipette up to 20 μ L marking. The blood sample and hydrochloric acid were mixed by stirrer. The solution in the tube was left as it is for 5 min to form acid hematin. The acid hematin was diluted by adding distilled water gradually with the dropper until it matched with the standard color plates of the comparator. Results were read as gram/dl and hemoglobin concentration was estimated up to the nearest 0.1 g/dl.

The subject was considered anemic if the hemoglobin level was <12 g/dl.²

Anthropometry was conducted using the standard protocol. Standing height (in cm) was recorded without shoes by the measuring tape which was mounted on the wall. Weight was

taken on a Krups Duchess weighing scale with light clothes and without shoes. Body weight was measured to nearest 0.1 kg and height was recorded to nearest 0.01 m for calculation of BMI.

BMI in kilograms/metre² was calculated using Quetelet formula as under:

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

Subjects were categorized into three groups on the basis of their BMI:

Group 1: Underweight (BMI <18.0 kg/m²)

Group 2: Normal (18.0–24.9 kg/m²)

Group 3: Overweight (>25 kg/m²)

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 20.0. (Armonk, New York: IBM Corp). Mean and standard deviation for hemoglobin levels and BMI were calculated and gender differences in them were analyzed by Student's independent *t*-test. Difference in the mean hemoglobin concentrations of the subjects according to BMI categories was tested by one-way analysis of variance and intergroup comparison was done by Tukey's *post hoc* test. Correlation between hemoglobin concentration and BMI of the study subjects was assessed by Pearson's correlation coefficient. $P < 0.05$ was considered statistically significant.

RESULTS

A total of 200 students were included in the study; however, 33 did not consent and so only 167 students were studied in the final analysis. There were 86 females and 81 males in our study. The mean age among female students was 19.53 ± 0.83 years and among male students was 19.50 ± 0.88 years.

The mean hemoglobin levels in females were statistically lower than males (10.7128 ± 1.9165 vs. 13.7321 ± 1.7072 , $P < 0.0001$). On correlating BMI with hemoglobin, Pearson's coefficient was -0.05 with $P = 0.481$, implying that there was no perfect correlation. However, clustering was seen at the middle of the data [Figure 1], meaning the students with a normal BMI had normal hemoglobin.

On comparing the three groups of BMI, it was seen that there was a statistically significant difference in the mean hemoglobin levels of the three groups (11.2167 ± 2.075 vs. 12.6642 ± 2.302 vs. 11.7844 ± 2.487 , $P = 0.028$). It was seen that the hemoglobin levels in Group 1 and Group 3 were lower as compared to Group 2.

DISCUSSION

Anemia and abnormal BMI in adolescence and early adulthood are associated with adverse outcomes in terms of

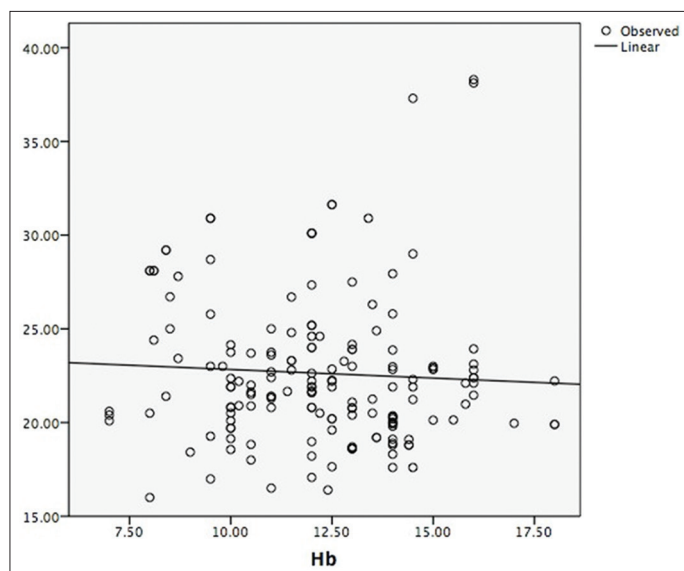


Figure 1: Correlation between body mass index and hemoglobin

reduced work output, poor academic performance, increased susceptibility to infections, loss of self-esteem, and increase risk of long-term morbidity and mortality. There is a high incidence of iron deficiency anemia during adolescence which may be further aggravated by abnormal BMI.^[8,9] In our study, mean hemoglobin levels in females were statistically lower than males (10.7128 ± 1.9165 vs. 13.7321 ± 1.7072 , $P < 0.0001$). On inter-group comparisons, it was seen that there was a statistically significant difference in the mean hemoglobin levels of the three groups, revealing inverse relation of hemoglobin levels with abnormal BMI groups (underweight and overweight groups). Underweight students had the lowest mean hemoglobin of 11.2167 ± 2.075 g/dl as compared to normal BMI students. We, in our study, had a negative correlation between BMI and hemoglobin levels in the overweight group, although it did not reach statistically significant values. Mean hemoglobin concentration in the overweight group was 11.7844 ± 2.487 g/dl, which was lower than the normal BMI group.

The reason for lower hemoglobin concentrations among female students is that there is a lower dietary intake of iron among girls coupled with the menstrual blood loss. Studies by Khakurel *et al.*,^[10] Khan *et al.*,^[11] Acharya *et al.*,^[12] and Sinha *et al.*^[1] have shown similar results in their studies. Previous studies have also reported a higher prevalence of anemia among underweight individuals. The plausible reason for it being that underweight predisposes to iron depletion and increases the risk of anemia. Khan *et al.*^[13] had similar observations in their study conducted in 2018. Another study from Ethiopia concluded that being underweight was a significant predictor (odds ratio +2.54, $P = 0.018$) of anemia in adolescents.^[14] Obesity or being overweight on the other hand is a risk factor for many diseases such as type 2 diabetes, hypertension, heart disease, stroke, sleep apnoea, and malignancies; also studies have shown that increase in

BMI has an adverse effect on iron status, the effect being more profound in females.^[15-18] The cause of iron deficiency anemia in individuals with high BMI is unclear. Iron deficiency in obese individuals may be a result of low iron intake (due to an unbalanced diet) which in our study seems to be the most plausible explanation, as most of the students were hostelers and consumed a large quantity of junk and readymade food which is nutritionally poor. In addition, reduced iron absorption in the small intestine, greater iron requirements caused by a larger blood volume and obesity being associated with chronic low-grade inflammation state are other proposed causes of iron deficiency in individuals with high BMI.^[19,20] A similar association between high BMI and hemoglobin concentration has been reported by Peter *et al.*^[21] among overweight and obese girls. Bulliya *et al.*^[22] also confirmed the negative correlation between high BMI and hemoglobin levels.

Limitations

The study was conducted on a convenient sample from a single medical college. A larger sample study would provide more generalized results.

CONCLUSION

From this study, it is concluded that abnormal BMI, whether underweight or overweight/obese, increases the risk of anemia. There is a negative correlation of hemoglobin concentration with BMI among individuals with abnormal BMI, as both low hemoglobin concentration and abnormal BMI have detrimental effects on the performance of an individual, effective screening, and management of both needs to be adopted, especially in undergraduate students in medical colleges.

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