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RESEARCH ARTICLE

A cross-sectional study of association between hemoglobin level and body mass index among adolescent age group

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ABSTRACT

Background: Hemoglobin (Hb) is the iron-containing protein in the red blood cells. Definition of adolescence by the WHO is as the period of life span between the age of 10–19 years. We have examined the association of body mass index (BMI) with Hb concentration in adolescence. **Aims and Objectives:** The aim is to study the association between hemoglobin level and BMI, sociodemographic factors, and comparison for the gender differences among adolescent age group. **Materials and Methods:** Of total 127 students, 50 students of a school (6^{th} to 10^{th} class), 50 PUC college students (11^{th} and 12^{th}), and 27 students from degree college in Raichur district were included, interviewed with pre-designed questionnaire, and physical examination including height, weight, and Hb level measured and BMI calculated. **Results:** Mean and standard deviation of 127 participant's age were 15.87 ± 2.592. Out of 127, 55.9% were male and 44.1% were female. There was a significant negative association between BMI (21.50 ± 2.64) and Hb level (12.30 ± 1.30). There was a significant positive association between Hb level and age. There was statistically highly significant high Hb among males compared to female. **Conclusion:** BMI and Hb levels are showing significant negative association in our study; significant positive association between Hb level and age; and significant positive association between height and Hb level. In our study, there was statistically highly significant high Hb among males compared to females, and there was significantly high BMI among females compared to males.

KEY WORDS: Adolescence; Body mass index; Hemoglobin

INTRODUCTION

Hb is the iron-containing protein in the red blood cells. The concentration of which provides information about the status of anemia in the population.

Anemia is defined as a common disorder of blood in which red blood cell's number, or the Hb concentration, decreases less than the established cutoff value, impairing the capacity of blood to carry oxygen in the body.[1]

Definition of adolescence by the WHO is as the period of life span between the age of 10–19 years.[2] It is the growing period of life when the most of physical, psychological, and also behavioral changes occur. It is the vulnerable period in the life cycle of human beings for developing nutritional anemia, which is often neglected by various public health programs.

Obesity leads to chronic diseases in old age and also during childhood as well. It also includes other diseases affecting the neurological system.[3,4] In addition to it, it also affects negatively on children's education. Various studies on this

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topic show that overweight/obese children show lower reading skills and low mathematics scores, poor in class's performance, student's less success, poor connection with schoolmates, and no desire for going school, so they cannot proceed further education in their life compared with that of normal weight children.[3,5]

Many studies conducted to date have focused on the association of the Hb level with BMI or obesity. Several studies have suggested that anemia and the Hb level are related to an increased BMI.

Anemia is a public health problem affecting more than 1.62 billion people worldwide, it is developing at different stages of the life cycle,[6] but children, adolescent, and women of the reproductive age are in major risk groups for anemia.[7] Anemia is a major concern for girls aged between 10 and 19 years,[8] as it is a period of higher growth with high iron requirement. This along with frequent menstrual blood loss and less dietary iron intake during this period causes anemia.[9] Anemia in adolescent is generally more prevalent in the developing countries like India,[9] and boys are less vulnerable than girls.[10]

High prevalence of obesity is always a global health problem. Dietary and lifestyle changes worldwide (especially in developing world like India) have brought a double-edged problem of malnutrition as under and for overnutrition in Indian population. Obesity is characterized with chronic, low-grade, systemic inflammation, associated with anemia of chronic disease, elevated serum ferritin and low serum iron, and Hb. A study confirmed that normal-weight children were half as likely to be iron deficient as that of overweight children.[11] Ausk and Ioannou showed that higher serum ferritin levels and lower serum levels of iron were associated with increasing BMI. However, there was no difference in Hb concentration in overweight, obese persons as compared with the normal-weight persons.[12]

A study conducted in 740 schoolchildren in Iran was showing the prevalence of iron deficiency which was higher with the student's BMI.[13]

A young developing child (aged 11–16 years) has very narrow level of status between the supply and requirement of iron stores. It is important to diagnose early the iron deficiency before it results in microcytic and hypochromic anemia. There was low Hb level in girls compared to boys in 58.28% volunteers of poor families.[14]

One study[15] conducted in Himalayan Institute of Medical Sciences showed that 8% female students were anemic, and also, BMI and Hb had a negative association, whereas study conducted in medical students of Amritsar[16] showed a positive correlation of Hb in both boys and girls with grades of BMI.

Therefore, we examined the association of BMI with Hb concentration. We hypothesized that high BMI individuals had lower iron status than their normal BMI equivalents do. Hence, we tried to establish any association between hemoglobin level and BMI among adolescent age group in Raichur district, which is one of the undeveloped districts of Karnataka state.

Aims and Objectives of Study

- To study sociodemographic factors in relation with hemoglobin level and BMI among adolescent age group
- To study association between hemoglobin level and BMI among adolescent age group
- Comparison for the gender differences in association between hemoglobin level and BMI among adolescent age group.

MATERIALS AND METHODS

This was a cross-sectional and descriptive study carried out among 127 adolescent age group individual (10–19 years old), from November 2018 to May 2019. For this study Proposal, Ethical approval was taken from Institutional Ethics Committee, RIMS.

Study Settings

Participants were selected after obtaining informed consent which includes 50 students of a school (6th to 10th class), 50 PUC college students (11thand 12th), and 27 students from degree college in Raichur district (all in the age group of 10–19 years). All the participants were informed about the procedure, and an individual demonstration about the procedure had been given to all the participants.

Inclusion Criteria

- Willing to give informed consent/assent
- Age between 10 and 19 years
- Under no history of any medications.

Figure 1: Sahli's Hemoglobinometer with pipette, hemometer tube, stirring rod, and dropper

Exclusion Criteria

- Conditions like hemorrhage in the past 6 months
- Vitamin B-12, or iron or folate treatment in the last year
- Blood donation done in the past 6 months
- Any infections, chronic diseases, or diabetes mellitus.

Instrument

Sahli's hemoglobinometer

Hb level was estimated by Sahli's method. The Hb tube was filled with hydrochloric acid of concentration N/10 up to 2 g % marking. This graduated tube was put in Sahli's hemoglobinometer. Figure 1 shows Sahli's Hemoglobinometer with pipette, hemometer tube, stirring rod, and dropper. Capillary blood was collected by the finger prick method, using 22G disposable needles, and blood were drawn into Sahli's pipette up to 20 microliter marking. The blood sample and hydrochloric acid were mixed by stirrer. The solution in the tube was left as it is for 10 min to form acid hematin. The acid hematin was diluted by adding distilled water gradually with the dropper till it matched the standard colored plates of comparator. Result is read as g/dl. The participant was considered anemic if the Hb level was <12 g/dl.

Anthropometric measurements, including height which was measured without shoes and person standing against a wall-fixed tape and while weight was measured without shoes and with light clothing on a flat scale with 1.0 kg subtraction for correction of weight.

The BMI was calculated as weight/height^2 (kg/m^2). For adults, normal (BMI = 18.5–24.99 kg/m^2), overweight (BMI = 25–29.99 kg/m^2), and obese (BMI = 30–34.99 kg/m^2), respectively, according to the latest WHO criteria.

Informed and written consent was obtained from all participants.

The data were analyzed with appropriate statistical test.

RESULTS

Table 1 shows age-wise distribution of all the participants in the study. Mean and standard deviation of 127 participant's age were 15.87 ± 2.592. Minimum age was 11 and maximum age was 19 (range – 8). Median was 16 and mode was 19. Standard error of mean was 0.23 and variance was 6.7.

Figure 2 shows gender-wise distribution of all the study participants, and it shows that 55.9% were male and 44.1% were female. Mean and standard deviation in male participant's age were 15.75 ± 2.817 and mean and standard deviation in female participant's age were 16.02 ± 2.292.

Table 2 shows correlation/association between BMI and Hb level. There was a significant negative association/correlation (−0.462) between BMI and Hb level. As BMI increases, Hb level decreases among adolescents.

Table 3 shows association/correlation between Hb level and age. There was a significant positive association/correlation

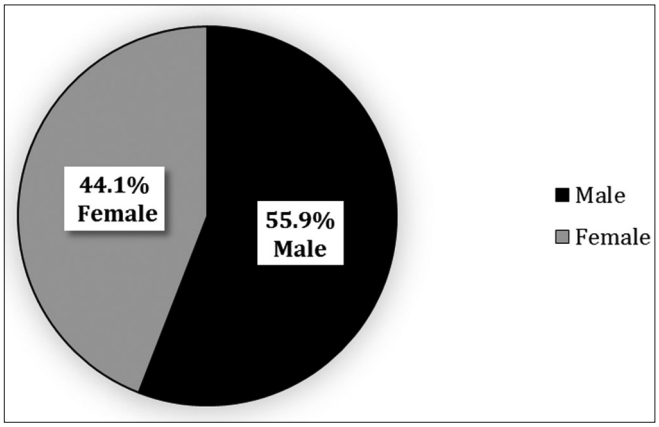

Figure 2: Gender-wise distribution of study participants

Table 1: Distribution of study participants age wise

Age	Frequency (%)
11	7 (5.5)
12	14 (11.0)
13	6 (4.7)
14	15 (11.8)
15	8 (6.3)
16	19 (15.0)
17	13 (10.2)
18	18 (14.2)
19	27 (21.3)
Total	127 (100.0)

Table 2: Correlation (association) between body mass index and hemoglobin level

Variables	Mean±SD	Correlation coefficient	*P*
BMI	21.50±2.64	−0.462	<0.0001
Hb	12.30±1.30		

SD: Standard deviation, BMI: Body mass index, Hb: Hemoglobin

Table 3: Association (correlation) between age and hemoglobin level

Variables	Mean±SD	Correlation coefficient	*P*
Age	15.87±2.59	0.553	<0.0001
Hb	12.30±1.30		

SD: Standard deviation, Hb: Hemoglobin

(0.553) between Hb level and age. As age increases, Hb level increases among adolescents.

Table 4 shows correlation/association between weight and Hb level. There was no significant association (0.034) between weight and Hb level.

Table 5 shows correlation/association between height and Hb level. There was a significant positive association between height and Hb level. Hb level increases with increasing height among adolescents.

Table 6 shows association between gender with BMI and Hb level. There was statistically highly significant high Hb among males compared to female. There was significantly high BMI among females compared to males.

Figure 3 is scatter diagram showing negative association between BMI and Hb.

Table 4: Correlation (association) between weight and hemoglobin level

Variables	Mean±SD	Correlation coefficient	*P*
Weight	55.69±8.14	0.034	0.703
Hb	12.30±1.30		

SD: Standard deviation, Hb: Hemoglobin

Table 5: Correlation (association) between height and hemoglobin level

Variables	Mean±SD	Correlation coefficient	*P*
Height	160.60±8.67	0.584	<0.0001
Hb	12.30±1.30		

SD: Standard deviation, Hb: Hemoglobin

Table 6: Association between gender with body mass index and hemoglobin

Variables	Sex	*n*	Mean±SD	*t*	*P*
BMI	Female	56	22.08±2.83	2.214	0.029
	Male	71	21.05±2.40		
Hb	Female	56	11.79±0.71	4.198	<0.0001
	Male	71	12.70±1.50		

SD: Standard deviation, Hb: Hemoglobin, BMI: Body mass index

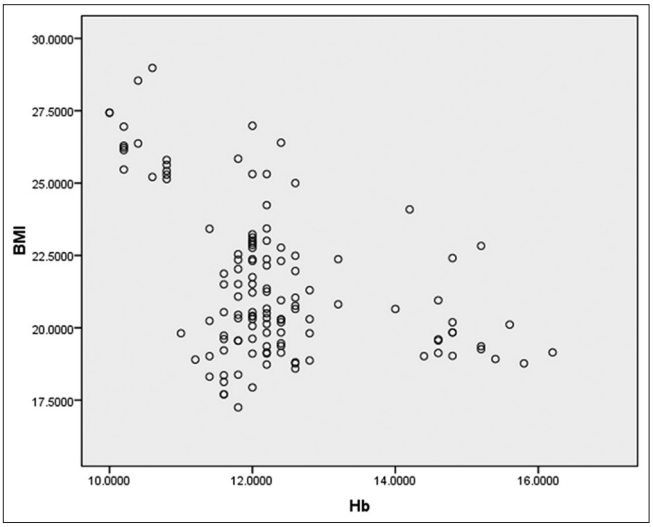

Figure: 3 Scatter diagram showing association between BMI and Hb

DISCUSSION

The present study was undertaken to study the association between hemoglobin level and BMI among adolescent age group along with sociodemographic factors and gender differences in 127 school and college students. In our study, mean and standard deviation of 127 participant's age were 15.87 ± 2.592. Minimum age were 11 and maximum age were 19 (range– 8). Median was 16 and mode was 19. Standard error of mean was 0.23 and variance was 6.7. Gender wise 55.9% were male and 44.1% were female. Mean and standard deviation in male participant's age were 15.75 ± 2.817 and mean and standard deviation in female participant's age were 16.02 ± 2.292.

In our study, there was a significant negative association between BMI and Hb level. As BMI increasing, Hb level decreases among adolescents. Similar finding was found in a study that normal-weight children were half as likely to be iron deficient as that of overweight children,[11] and also, in one another study, the prevalence of iron deficiency was higher with the student's BMI.[13] However, one another study shows contrary to that, there was no difference in Hb concentration in overweight, obese persons as compared with the normal-weight persons.[12]

One study[15] in Himalayan Institute of Medical Sciences and another study[17] in MKCG Medical College, Berhampur, Odisha, found a negative association between BMI and Hb similar to our study, whereas another study conducted in medical students of Amritsar[16] showed a positive correlation of Hb in both boys and girls with grades of BMI.

We observed that there was a significant positive association between Hb level and age. As age increases, Hb level increases among adolescents. There was no significant association (0.034) between weight and Hb level. There was a significant positive association between Height and Hb level. Hb level increases with increasing height among adolescents. While in one another study[17] in MKCG Medical College, Berhampur, Odisha, found a negative association between Hb and height, Hb and weight, and Hb and BMI.

In our study, it was statistically highly significant high Hb among males compared to female. Similar finding in one study conducted by Jamali *et al.*[14] that Hb level was low in girls than boys. In our study, mean Hb in boys was 12.70 g/dl

±1.50 and in girls was 11.79 g/dl ±0.71 while similar findings in one study,[18] mean Hb value in boys was 13.38 g/dl (±1.70) and 11.75 g/dl (±1.15) in girls.

In the present study, there was significantly high BMI among females compared to males, which is contrary to a study conducted in Ambala,[19] where mean BMI among male students (23.7 ± 3.6 kg/m^2) was more than that of female students (21.8 ± 3.5 kg/m^2).

Strengths and Limitations

Strength of the study is that it shows significant negative association between BMI and Hb and significant positive association between age and Hb level. We have taken sample from different three schools and colleges, which represent different age groups in adolescent, while limitation is our sample size is 127, and we have done study in school and college. The same study can be conducted in community with larger sample size.

CONCLUSION

The present study was undertaken to study the association between hemoglobin level and BMI among adolescent age group. There was a significant negative association between Hb level and BMI; significant positive association between Hb level and age; and significant positive association between height and Hb level. In our study, there was statistically highly significant high Hb among males compared to females. In the present study, there was significantly high BMI among females compared to males.

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