



## ASSOCIATION OF BMI (BODY MASS INDEX) TO HEMOGLOBIN AND RED BLOOD CELL INDICES AMONG ADOLESCENTS.

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### Article received on:

07/01/2020

### Accepted for publication:

15/04/2020

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**ABSTRACT... Objectives:** Hemoglobin & red blood cell indices (mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, red cell distribution width) among adolescent. **Study Design:** Cross-Sectional study (Descriptive). **Setting:** Department of Physiology, Baqai Medical University (BMU) Karachi. **Period:** 6 months from February to August 2017. **Material & Methods:** A total of 500 students of MBBS, BDS, DPT with having age ranges from 18-25 years were enrolled in this study. The anthropometric measurement [height (m<sup>2</sup>) and weight (kg)] was recorded for calculation of the Body Mass Index and Complete blood count i-e Hemoglobin (Hb%), Mean Corpuscular Volume (MCV), Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC), Red cell distribution width (RDW) was done and calculated. Data analysis was done on Microsoft excel & SPSS version 22.0 was used. **Results:** It was seen that the comparison of Hb%, MCV & RDW had no significant ( $p > 0.001$ ) association of study participants to different categories of Body Mass Index. Mean corpuscular hemoglobin (MCH) ( $X^2 = 28.278$ ,  $p < 0.001$ ) and Mean corpuscular hemoglobin concentration (MCHC) ( $X^2 = 15.659$ ,  $p = 0.016$ ) were statistically significantly association with different categories of Body Mass Index. **Conclusion:** Mean corpuscular hemoglobin and Mean corpuscular hemoglobin concentration had statistically significant ( $p < 0.001$ ) association with body mass index (BMI).

**Key words:** Anemia, Body Mass Index (BMI), Red Blood Cell Indices.

**Article Citation:** Abro SU, Saleem Q, Begum A, Azhar S, Naseer A, Qureshi AA. Association of BMI (Body Mass Index) to hemoglobin and red blood cell indices among adolescents. Professional Med J 2020; 27(10):2210-2215.  
**DOI:** 10.29309/TPMJ/2020.27.10.4470

## INTRODUCTION

World health organization (WHO) describes the health, as a state of being a complete physical, mental and social wellbeing and it is not merely the absence of disease or infirmity in human body.<sup>1</sup> Human Body composition changes from infancy to adolescence significantly regarding relative and absolute variation in the content or amount of protein, lipid, water and minerals. Adolescence is the stage of human life between the ages of 10–19 years, during which rapid growth spurt occurs in human body which leads to increased nutritional (micronutrients and macronutrients) demand.<sup>2</sup> The nutritional and health status of human body can be measured by Body Mass Index (BMI) or Quetilet index i-e by assessing height (meters square), weight (kilograms) of an individual.<sup>3</sup> The Quetilet index or Body Mass Index indicates the amount of

body tissue masses of human body; these are bones, muscles, and fats. The Quetilet index or Body Mass Index is a simple, inexpensive, and non-invasive method of measurement of body fat (BF) in human body. Body fat (BF) is used in the human body as the source of energy, heat insulation and shock absorption. If excessive fat is deposited in the human body, which ultimately leads to hyperlipidemia or overweight or obesity. So, it is considered as dangerous to human life, which ultimately leads to future morbidity and death. *Excessive fat deposition is due to decreased physical activity or lack of activity or increased food intake or increased caloric intake.*<sup>4</sup> According to WHO; overall, 13% of individuals are obese or having high BMI in the world, which is round about 0.65 billion individuals.<sup>5</sup> In Pakistan, 5.4% (7.2 million people) of the total adult population is having the high BMI or having

the obesity, so our country is ranked 20<sup>th</sup> in whole world.<sup>6</sup> Increased body fat or increased adipose tissue is responsible for development of high blood pressure (hypertension), diabetes mellitus (DM) or metabolic syndrome (MS), cardiovascular diseases (CVD), respiratory diseases and it also affects iron metabolism. High BMI or obesity is associated with subclinical inflammation that leads to development of anemia.<sup>7</sup> Anemia (decreased Hb% concentration below normal level or decreased erythrocyte count below normal level) is a global problem and it occurs more in the developing countries. It occurs due to dysfunction in the production of erythrocytes (erythropoiesis), recycling and regulation of erythrocytes or red blood cells (RBCs).<sup>8</sup> Obesity or high BMI and anemia (iron deficiency) are two forms of the most commonly prevalent nutritional disorders in whole world. Among nutrients, iron (micronutrients) plays a vital role in Hb% synthesis, oxidative metabolism (anabolism and catabolism), and energy or ATP production. It affects the cognitive development and behavior, energy or ATP metabolism, immune system, bone health, and work capacity or work performance in humans.<sup>9</sup> Red blood cells (RBCs) indices are used for assessment of physical characteristic of the erythrocytes or red blood cells (RBCs) and also used for the diagnosis of anemia and its type (microcytic or macrocytic anemia). It includes calculated values of Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC), Mean Corpuscular Volume (MCV).<sup>8</sup> The association b/w high BMI or obesity and anemia should be further workup as both are affecting the health status of human body. The aim and objective of this study was to evaluate the association of body mass index (BMI) to hemoglobin & red blood cell indices (mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, red cell distribution width) among adolescent.

## MATERIAL & METHODS

This is a Descriptive Cross-Sectional study. This study was conducted in department of Physiology, in Baqai Medical University (BMU) Karachi.

This study was done over a period of six months from February 2017 to August 2017.

500 adolescent's students of MBBS, BDS and DPT classes were included. It was calculated with confidence level of 95% and error of margin is 5%.

The sampling technique used was Non probability purposive.

### Inclusion Criteria

Those students of MBBS, BDS and DPT classes were Healthy and interested in research and had a written or informed consent, were recruited in this study.

### Exclusion Criteria

Students having history of (H/O) thalassemia major or minor, H/O intake of vitamin B12, folate and iron therapy, H/O blood transfusion of packed cells or whole blood or Blood donation in last six months, H/O perianal itching or passing worms in stools, H/O malabsorption or malnutrition disorders and H/O surgery (Ileal) leading to deficiency of vitamin B12 (macrocytic anemia).

It was started after taking ethical review board (ERB) from Baqai Medical University Karachi. The written or informed consent were obtained from every enrolled student before start of participation in a research with briefing the research procedure. Enrolled students data were gathered with the help of pre-tested or structural questionnaire. Five hundred (500) blood samples were collected from participants or adolescent's students. All students underwent hematological or laboratorial investigation. Three millimeter (3cc) of blood had been collected in a tube (CP bottle) containing anticoagulant: ethylene diamine tetra acetic acid (EDTA). Complete Blood Count (CBC) was performed by Sysmex (XS-1000i) automated flow meter within minutes of collection. Complete Picture (CP) was performed as to assess and record hemoglobin (Hb%) and red blood cell indices (MCV, MCH, MCHC) levels. Red blood cells (RBCs) indices were calculated (MCH, MCHC & MCV) by using different formulas. Mean corpuscular hemoglobin (MCH) is calculated by Hemoglobin (Hb%) X 10/R.B.C

and is expressed in picogram. Mean corpuscular hemoglobin concentration (MCHC) is calculated from Hemoglobin (Hb%) X 100/ Hematocrit and is expressed in gm/dl. Mean Corpuscular Volume (MCV) is calculated by Hematocrit X 10/R.B.C and is expressed in femtoliter.<sup>10,11</sup> The anthropometric measurement was assessed for calculation of the BMI. The height of students was measured by measuring tape in centimeters, which converted to meters and weight of students were measured in kg by digital scale [height (m)<sup>2</sup> and weight (kg)], according to recommendations of SI unit. Participants of the study were classified into groups; underweight, normal, overweight and obese on the basis of WHO criteria<sup>12</sup> and considered as an independent of age and sex. As it is considered as marker of nutritional status of adolescents.<sup>13</sup>

$$\text{BMI} = \text{Weight} / \text{Height (Kg/ meters}^2\text{)}.$$

The collected data was entered in Microsoft excel & analyzed by using Statistical Package for Social Sciences (SPSS) version 22.0. The qualitative variables were expressed as Frequency and percentages (%). The quantitative gathered data were expressed as mean and standard deviation ( $\pm$ ). The post stratification Chi-Square test was applied with confidence level 95% and having significant ( $p\text{-value} < 0.05$ ) and non-significant ( $p\text{-value} > 0.05$ ) values.

### RESULTS

Table-I to II it was seen that the mean and the standard deviation of age in study participants was  $20.35 \pm 1.69$  years. The mean and the standard deviation of height, weight, and BMI were  $2.70 \pm 0.30$  in meters,  $61.92 \pm 10.75$  in kg and  $23.04 \pm 3.68$  respectively. The mean and the standard deviation of Hemoglobin, MCH, MCV, MCHC and Red Cell Distribution Width (%) were  $13.29 \pm 2.06$ ,  $26.89 \pm 3.89$ ,  $80.66 \pm 8.48$ ,  $32.90 \pm 2.67$  and  $42.80 \pm 21.84$  respectively. Table-I to III: shows the comparison of red blood cell indices of study participants for different categories of BMI and it was seen that only MCH ( $X^2 = 28.278$ ,  $p < 0.001$ ) and MCHC ( $X^2 = 15.659$ ,  $p < 0.016$ ) were statistically significantly different from each other. For MCH, a majority of those were underweight or

obese had a low level of hemoglobin (55.0% and 44.4% respectively) whereas a majority of those who had normal weight or were overweight had a normal level of hemoglobin (60.4% and 67.1% respectively). For MCHC, a majority of those were underweight, normal weight or overweight had a normal level of hemoglobin (61.7%, 55.6% and 60.8% respectively) whereas a majority of those who were obese had a low level of hemoglobin (44.4%).

Classification	Values of BMI(kg/m <sup>2</sup> )
Under weight	< 18.5 kg/m <sup>2</sup>
Normal	18.5 to 24.99 kg/m <sup>2</sup>
Over weight	25 to 29.99 kg/m <sup>2</sup>
Obese	>30 kg/m <sup>2</sup>

**Table-I. Levels of BMI according to WHO criteria.**

Variables (n=500)	Mean	$\pm$ S.D.
Age (Years)	20.35	$\pm 1.69$
Height (m)	2.70	$\pm 0.30$
Weight (kg)	61.92	$\pm 10.75$
BMI (Kg/m <sup>2</sup> )	23.04	$\pm 3.68$
Hemoglobin	13.29	$\pm 2.06$
MCH	26.89	$\pm 3.89$
MCV	80.66	$\pm 8.48$
MCHC	32.90	$\pm 2.67$
Red Cell Distribution Width (%)	42.80	$\pm 21.84$

**Table-I. Evaluation of descriptive statistics of the studied population. (n= 500).**

### DISCUSSION

Health of Human body can be assessed by using various parameters like using labs (biochemically) or using anthropometric measurements, etc. Body mass index (BMI) and Hemoglobin (Hb%) concentration are some of the most popularly used parameters as to evaluate the human body health.<sup>14</sup> The present research was done in adolescent's students as to study the association of body mass index (BMI) to hemoglobin (Hb%) & red blood cell (erythrocytes) indices. This study consists of 500 students in which mean age was  $20.35 \pm 1.69$  and mean body mass index (BMI) was  $23.04 \pm 3.68$ .

Variable (n=500)	BMI			
	Underweight	Normal Weight	Overweight	Obese
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
<b>Hemoglobin Level</b>				
Low	23(38.3%)	111(38.5%)	45(31.5%)	3(33.3%)
Normal	35(58.3%)	168(58.3%)	96(67.1%)	6(66.7%)
High	2(3.3%)	9(3.1%)	2(1.4%)	Nil
P-Value	>0.65			
<b>MCH</b>				
Low	33(55.0%)	108(37.5%)	45(31.5%)	4(44.4%)
Normal	26(43.3%)	174(60.4%)	96(67.1%)	3(33.3%)
High	1(1.7%)	6(2.1%)	2(1.4%)	2(22.2%)
P-Value	<0.001			
<b>MCV</b>				
Low	24(40.0%)	110(38.2%)	44(30.8%)	5(55.6%)
Normal	36(60.0%)	177(61.5%)	99(69.2%)	4(44.4%)
High	Nil	1(0.3%)	Nil	Nil
P-Value	>0.557			
<b>MCHC</b>				
Low	22(36.7%)	114(39.6%)	55(38.5%)	4(44.4%)
Normal	37(61.7%)	160(55.6%)	87(60.8%)	3(33.3%)
High	1(1.7%)	14(4.9%)	1(0.7%)	2(22.2%)
P-Value	<0.016			
<b>Red Cell Distribution Width (%)</b>				
Normal	2(3.3%)	21(7.3%)	8(5.6%)	Nil
High	58(96.7%)	267(92.7%)	135(94.4%)	9(100%)
P-Value	>0.547			

**Table-III. Association between BMI and Red Blood Cell Indices.**  
**P < 0.05 shows significant values and P > 0.05 shows non significance values. \*Chi-Square Test**

In our study, there were significant associations MCH ( $p < 0.001$ ) and MCHC ( $p < 0.016$ ) in comparison of red blood cell indices of study participants to different categories of body mass index (BMI). Awad KM et al. had observed no significant association ( $p > 0.001$ ) of MCH and MCHC compared to different categories of body mass index (BMI) in his study<sup>7</sup> so this result is against to our findings. In our study, there were no significant association ( $p > 0.001$ ) between Hb%, MCV & RDW% to different categories of body mass index. Iranian and Indian study had observed that body mass index have no significant ( $p > 0.001$ ) association with hemoglobin (Hb%) level & MCV, so it that supports our results.<sup>15,16</sup> As body mass index (BMI) is increases, hemoglobin (Hb%) level decreases in the adolescents students like that results were observed in study this inverse

association between high BMI or obesity and anemia is due to increase intake of high caloric junk foods.<sup>7,17</sup> The coexistence of overweight or obesity and anemia could be result of the energy dense foods consumption on regular bases as these are poor in iron content or it occurs due to poor iron absorption from gut and /or poor utilization that may occur due to chronic inflammation.<sup>18</sup> Iranian study was observed also that higher prevalence of anemia (iron deficiency) in students with high BMI.<sup>19</sup> Two other studies done in Indian medical adolescents students, they had observed no significant ( $p > 0.001$ ) association between body mass index with hemoglobin level, that supports our study finding.<sup>20,21</sup> Overweight and obesity or high BMI is characterized by chronic, low-grade, systemic inflammation, that leads to anemia of chronic disease<sup>15</sup> or high BMI is

associated with inflammation (sub-clinical) which is responsible for the development of anemia.<sup>7</sup> Many researchers had observed that anemia had directly association with physical inactivity or lack of exercise, lack of extracurricular activities and generalized obesity.<sup>22,23,24</sup> Anemia mainly affects the physical performance or extracurricular activities, school or college performance, daily attendants in classes, difficulty in concentration in studies, which ultimately distracts the normal health and socioeconomic status.<sup>23,25</sup> The present study was having limited number of participants and source of funding, so in future this should be on large scale including gender based study, status (class) based study and laboratorial test like ESR, CRP, FERRITIN level and hemoglobin electrophoresis should be done, as to achieve the cause of anemia in participants.

## CONCLUSION

It was seen that the comparison of Hb%, MCV & RDW had no significant association ( $p > 0.001$ ), while MCH ( $p < 0.001$ ) and MCHC ( $p = 0.016$ ) were statistically significantly association with different categories of Body Mass Index in this study.

## Conflict of Interest

Author has no conflict of interest in this study.

## Acknowledgment

The author will be thanking to the study volunteers for their participation.

## Source of Funding

This study was funded by the Baqai Medical University Karachi, Pakistan.


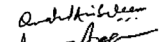
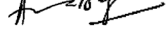


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3	Amna Begum	Proof reading, Drafting.	
4	Sarah Azhar	Proof reading, Lab technical facilitation.	
5	Amber Naseer	Literature search.	
6	Aijaz Ahmed Qureshi	Review, Discussion.	