Association of body mass index with hemoglobin level, erythrocyte indices and red cell distribution width.

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ABSTRACT… Objectives: Objective of this study is to evaluate the association of body mass index with hemoglobin Level, erythrocyte Indices and red cell distribution width in medical students of Baqai Medical University Karachi. Study Design: Descriptive cross - sectional study. Setting: Physiology Department of Baqai Medical University Karachi. Period: 15 February 2017 to 15 August 2017. Material & Methods: A total of 500 students were enrolled in this study. The anthropometric measurement [height (m^2) and weight (kg)] was recorded for calculation of the Body Mass Index and Complete blood count i-e Hemoglobin%, erythrocyte indices {Mean corpuscular volume(MCV), Mean corpuscular hemoglobin(MCH), Mean corpuscular hemoglobin concentration (MCHC), Red cell distribution width (RDW) were done and Mentzer's Index was calculated. Statistical Package for the Social Sciences (SPSS) version 22.0 was used to analyze the collected data. Results: It was observed in 500 medical students that 36% of the students were having low hemoglobin % level, while low values of erythrocyte indices (MCH: 38.0%, MCV 36.6% and MCHC 39.0% respectively) and 93.8% of participants had a higher values of RDW in study participants. Iron deficiency anemia (87.2%) and thalassemia (carrier or minor: 12.8%) were determined by using Menterzer Index. Mean body mass index of study participants were 23.04±3.68 and it was observed in study participants that only RDW was significantly associated with obese students ($X^2=9.878$, p=0.02). Conclusion: With regard to our study results, higher percentage (87.2%) of Iron deficiency anemia were observed and having association between red cell distribution width to obesity.

Key words: Anemia, Body Mass Index, Hemoglobin, Obesity.

INTRODUCTION

Obesity and Anemia are major health challenges in this twenty first century, mostly in children and adolescents, especially in the female gender. Obesity or overweight is increasing dramatically in low, middle-income countries (LMIC). This burden of overweight and obesity is increasing due to rapid change in lifestyle and dietary modifications in these developing countries. Nowadays, mostly these conditions are prevalent in developing countries and have devastating effects on the physical and mental health of a human body.[1] Obesity and Anemia are intractable issues of adolescent's age group in whole the world (developed & developing countries). Worldwide, obesity or High Body Mass Index (BMI) has been tripled since 1975. According to the world health organization (WHO), overall, 13% of people are obese in the world, which is comprised around 0.65 billion people.[2] Obesity or overweight is associated with many co-morbidities like Ischemic heart disease (IHD) or Coronary heart diseases (CHD), Diabetes mellitus (DM), Metabolic syndrome (MS), High arterial blood pressure or High blood pressure, Liver disorders, Psychological disturbances and different types of cancers. Anemia is considered as a devastating health problem and iron deficiency anemia is associated with under nutrition and obesity. In Pakistan, 5.4% of the total adult population is obese, which is comprised around 7.2 million people, so it is ranked 20th in the world. In Pakistan, prevalence of anemia is 30% and half of the community belongs to iron deficiency anemia.[3]

Anemia occurs when the concentration of hemoglobin is decreased below 12.0 gm/dl, that affects oxygen-carrying capacity, and body tissue cells receive less concentration of oxygen.[4,5] This also affecting the aerobic metabolism, leading to less energy for the proper function of the human body. Each red blood cell (RBC) or erythrocyte contains between 200 and 300 molecules of hemoglobin which binds with oxygen. Anemia can occur from a dysfunction in the production, recycling or regulation of erythrocytes in the body. The physical characteristic of the erythrocytes is assessed by the RBCs indices. It is also used for the diagnosis of anemia and its type. Erythrocyte or RBCs indices include values of Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC), Mean Corpuscular Volume (MCV). Red cell distribution width (RDW) assesses the variations in the size of erythrocytes. It is a marker of inflammation or it reflects the inflammatory state in the human body.[6] Mentzer stated an index that is used for differentiating the two different types of anemia's, the thalassemia and iron deficiency anemia.[7] Globally, the prevalence of anemia is 43% in developing countries and about 9% is in developed nations.[8] Anemia affects growth, cognitive functions, extracurricular activities, lack of interest in attending the classes, daily activities and general weakness in both male and females. As university students are in the growing phase, so there is a rapid and sudden increase in the growth of the body, so there is an increased demand for nutrition (Micronutrient and Macronutrients). Many factors are responsible for development of nutritional deficiencies like sedentary lifestyle or loneliness as to achieve course work, hostel, use of cold beverages or junk foods, less time for physical activities, lack of balanced diet and poor eating habits. According to World Health Organization (WHO), nutrition is categorized into good and poor nutrition, and it depends upon the availability of micro and macronutrients in food. Immunity is directly affected by lack of micro and macronutrients in foods, so prone to develop various disease, ultimately work performances will be affected.[9] Obesity and Anemia are due to lack of a balanced diet in University students because of poor knowledge of healthy eating habits. These factors are responsible for developing communicable and non-communicable diseases.[3] Obesity or High body mass index is always occurs due to increased energy intake than energy expenditure in daily life activities.[10] Usually, iron deficiency anemia develops gradually and clinically appears as requirements are increased during adolescence and in adulthood. The association of BMI with hemoglobin level, RBCs indices, and red cell distribution width in medical students is our objective of this study.

MATERIAL & METHODS

This is a cross-sectional study, conducted in students of MBBS, BDS, DPT at Baqai Medical University, Karachi. Total 500 medical students, age ranges from 18-25 years were included. Ethical reviews Committee of Baqai Medical University have given Ethical clearance of this study. All the students had briefed about the research significance and its procedure. All those participants, who had given consent & had no co-morbidity were enrolled for this study. The students were having history of heamoglobinopathies (thalassemia major or thalassemia minor), worm infestation, peptic ulcers, menstrual history from the female participants or having a history of bleeding, blood donation, drug history (heamatinics) were excluded. This study was done in 2017 from February to August. Demographic Data were collected which includes name, age, gender, ethnicity and each individual is allotted a separate number for identification. Data is collected from participants by using a pre-tested questionnaire. Students were seated comfortably on a chair. Blood sample of three millimeters (ml) has taken from participants in CP bottle containing anticoagulant (Calcium EDTA). The blood sample was analyzed in the analyzer and results like hemoglobin (Hb%), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV) & red cell distribution width (RDW) are included. Blood was analysed on sysmex XP100 from EDTA anticoagulated blood by using Stromatolyser WR (500) and cell pack (20ml) provided by Sysmex Asia Pacific Pte Ltd. The Hemoglobin (Hb%) is

present in erythrocytes, and an oxygen-carrying conjugated protein. Its concentration in males and in females (14-18 gm/dl and 12-15.5gm/dl respectively). When the concentration of Hb% levels below these readings will be considered as anemia.[4] The packed cell volume (PCV) are erythrocytes and its concentration in males and females (45%&42% respectively). The hematocrit (Hct%) or PCV values are affected in anemia as well as in polycythemia. The MCV is the average volume of a single erythrocyte and calculated by dividing Hct% by erythrocytes (normal range is 80 to 100 fl). The mean corpuscular hemoglobin is defined as an average mass of hemoglobin % in one erythrocyte in unit and unit is Pictograms ($pg = 12^{-10}$ gr). The hemoglobin (Hb%) is divided by the red blood cells and its range is 27 to 33 pg. The mean corpuscular hemoglobin concentration (MCHC) is the hemoglobin concentration in the erythrocyte or red blood cells, and the volume of red cells in percentage (%) in 100 ml of blood and multiplied by 100. The Variations in the volume of red blood cells are assessed by red cell distribution width (RDW) with its normal range is 11.5-14.5%. It is achieved by the percentage ratio of MCV to MCV. Its formula: RDW-CV= (S.deviation of MCV divided by MCV) × 100). The Red Blood Cell indices used for the diagnosis of anemia and its type. Mentzer stated an index that is used for differentiating the type of anemia into thalassemia and iron deficiency anemia and is calculated as Mean corpuscular volume per erythrocyte count (RBCs count). If the quotient of Mentzer index is less than 13 than diagnosis most probably will be thalassemia. Iron deficiency anemia had a Mentzers quotient greater than 13. The anthropometric measurement [height (m)^2 and weight (kg)] was recorded for calculation of the Body Mass Index. The measuring tape was used to measure height in inches, which was converted to meter square and weight in kg measured by digital scale (Kg/m^2), according to recommendations of SI unit. Participants of the study were classified on the basis of WHO criteria.[11]

BMI=Weight/ Height (Kg/ meters^2).

Collected data were double checked before entry in sheets, and 22.0 version Statistical Package Social Sciences (SPSS) used. Categorical variables are presented as frequency (n) and percentage (%) and descriptive statistics (Continuous variables) like age, height, weight, BMI, Hb%, PCV or hematocrit %, MCH, MCHC, MCV,RDW & Mentezers Index, were analyzed. The association of BMI with Hb% level, red blood cell indices and RWD were assessed by Kruskal-Wallis H Test. Microsoft window 7 was used to generate tables in this study.

RESULTS

Study was comprised of 500 students of mean age 20.35±1.69. Descriptive statistics (Continuous variables) like Height, Weight, BMI, Hb%, RBCs count, PCV, MCH, MCHC,MCV, RDW, Menters index are described in Table-I to II. Of total studied population 36.4% of them had a low hemoglobin level and almost similar percentage of them had low values of MCH, MCV and MCHC (38.0%, 36.6% and 39.0% respectively) and 93.8% of them had high red cell distribution width. Mentzer Index classified anemia further into thalassemia and iron deficiency anemia (12.8% & 87.2% respectively). In Table-III had shown the results of underweight, overweight and obese (12.0%, 28.6% & 1.8%). Table-IV had shown the comparison of red blood cell indices of study participants for different categories of BMI and it was seen that only Red cell Distribution Width was significantly different between them (X^2=9.878, p<0.02), whereas the study participants who were obese had higher mean rank of RDW than those who were underweight, normal weight and overweight (326.78 vs. 259.75, 234.69 and 273.78 respectively) and there is no association of hemoglobin Mean Rank, MCH Mean Rank, MCV Mean Rank and MCHC Mean Rank with different categories of Body Mass Index (BMI).

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

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

Variables (n=500)	Mean± S.D.
Age (Years)	20.35±1.69
Height (m)	2.70±0.30
Weight (kg)	61.92±10.75
BMI (Kg/m^2)	23.04±3.68
Hemoglobin	13.29±2.06
RBCs count	4.98±0.74
Hct%	39.5±6.15
MCH	26.89±3.89
MCV	80.66±8.48
MCHC	32.90±2.67
Red Cell Distribution Width (%)	42.80±21.84
Menters Index	16.52±3.48

Table-II. Evaluation of descriptive statistics of the studied population (N= 500).

Variables (n=500)	Frequency	Percentage (%)
BMI		
Underweight	60	12.0%
Normal Weight	288	57.6%
Overweight	143	28.6%
Obese	9	1.8%
Hemoglobin		
Low	182	36.4%
Normal	305	61.0%
High	13	2.6%
MCH		
Low	190	38.0%
Normal	299	59.8%
High	11	2.2%
MCV		
Low	183	36.6%
Normal	316	63.2%
High	1	0.2%
MCHC		
Low	195	39.0%
Normal	287	57.4%
High	18	3.6%
Red Cell Distribution Width (%)		
Normal	31	6.2%
High	469	93.8%
Mentzer Index		
Normal	64	12.8%
High	436	87.2%

Table-III. Evaluation of Body Mass Index, Hemoglobin, Erythrocyte Indices (MCH, MCHC, MCV), RDW and Mentzers Index. (N= 500).

DISCUSSION

Obesity and anemia are important health challenges worldwide (developed countries & in developing countries), particularly in adolescents and in the female gender, which had effects on physical and mental health. The Anemia and its type can be assessed by doing a complete blood count (CBC). Contributing factors in the development of Anemia include hemoglobinopathies, worm infestation, and menstrual disorders in females but the leading cause of anemia is an iron deficiency or lack of iron in the diet. Prevalence of excessive BMI (overweight and obesity) had increased in whole-world, including developed & developing countries and was thought as a health issue.[12] It was caused by factors like genetics and environmental factors (i-e junk foods or drinks).[13] Main causes of high Body mass index (BMI) are a sedentary lifestyle and consumption of junk foods along with the use of smart technologies of the modern world including laptops, so it will be reducing or cutting down the healthy eating habits and outdoor activities.[14] High BMI (Obesity) is a risk factor for many diseases such as type 2 diabetes Mellitus, hypertension, heart disease, Ischemic Heart diseases, stroke, dyslipidemia, osteoarthritis, gynecological problems, sleep apnea syndrome, and respiratory problems. Also, studies showed that obesity has an adverse effect on iron status.[3,15-16] It was observed in study results that 36.4% of the students had a low hemoglobin level and low values of MCH, MCV and MCHC (38.0%, 36.6% and 39.0% respectively) with 93.8% had high red cell distribution width. According to Mentzer Index, 12.8% of study participants had a thalassemia (carrier or minor) and 93.8% had iron deficiency anemia. (Table-III) and the comparison of red blood cell indices of study participants for different categories of BMI and it was seen that only Red cell Distribution Width was significantly different between them (X^2=9.878, p<0.02) where the study participants were associated with obese and had higher mean rank of RDW than those who were underweight, normal weight and overweight (326.78 vs. 259.75, 234.69 and 273.78 respectively) (Table-IV). The RDW is playing an important role for prognosis in CCF.[17] The RDW is useful for measuring the variation in the width of the red blood cells and diagnostic marker for the type of anemia. The RDW is an indicator of oxidative stress and inflammatory process in

Variable	Hb% Mean Rank	MCH Mean Rank	MCV Mean Rank	MCHC Mean Rank	RDW Mean Rank
BMI					
Underweight (<18.5)[1]	237.66	226.53	237.06	243.88	259.75
Normal Weight (18.5-24.9)[2]	253.61	251.39	243.13	248.14	234.69
Overweight (25.0-29.9)[3]	250.97	250.97	272	256.06	273.66
Obese (≥30.0)[4]	229.06	229.06	234.39	281.78	326.78
P-Value[5]	>0.847	>0.529	>0.208	>0.84	<0.02

Table-IV. Association of Body Mass Index with Hemoglobin Level, Erythrocyte Indices (MCH, MCHC, MCV) & RDW. (N= 500).
Significant values (P < 0.05) and non significance values (P > 0.05).
[1]n=60,[2]n=288,[3]n=143,[4]n=9,[5]Kruskal-Wallis, H Test.

Chronic Obstructive Pulmonary Disease (COPD). It projects the risk of cardiovascular diseases especially in which inflammatory process occurring and had association atrial fibrillation postoperatively.[18] The RDW acts as a predictor of microalbuminuria.[19] This is due to the fact that RDW is increasing in impaired erythropoiesis (impaired maturation of RBCs).

Red blood cell size variation reflects the inflammatory process and oxidative stress in the body and associated with signs of type 2 DM.[20] According to cohort study, there had no association between hematological indices and in subgroups of BMI.[21] Association between anemia and BMI were in other studies.[22] Our study results showed no association of hemoglobin Mean Rank, MCH Mean Rank, MCV Mean Rank and MCHC Mean Rank with different categories of Body Mass Index (BMI). These results are in contrast to previous observations.[23]

It was observed that obese subjects have higher level of hepcidin and low level of serum iron than non-obese. It is observed in study population that iron deficiency and anemia are more frequent with progressing morbid and may be due to elevated iron regulatory hormone, hepcidin which blocks cellular export of iron by blocking iron exporter ferroprotein (FPN) in duodenal enterocytes.[24] Anemia (its type) and obesity, Researches on big scale should be done as to explore the exact mechanism of anemia (its type) in obesity in the adolescents or teenager groups for effective prevention and promotion of health in the local population.

CONCLUSION
The RDW is only significantly associated (P < 0.05) with different categories of body mass index, especially in obese adolescents. It is an obligation on us to take steps toward the alleviation non-communicable diseases like decreased hemoglobin, thalassemia, increasing BMI worldwide. It is burden and health hazards in developing and developed countries.

RECOMMENDATIONS
Recommendations modify the life style, modify the dietary habits, promotion of physical exercises, use of fresh fruits and use of vegetables in diet and avoidance of junk foods. Regular Awareness programs and screening programs should be arranged for anemia, obesity or morbid obesity and thalassemia in society. So that younger population can adopt healthy habits before they develop on-toward effects on health.

LIMITATIONS OF STUDY
In this study limited university students were included, and also limitations in fund. We had done only CBC and BMI, while other parameters like iron profile, serum hepcidin, Hb% Electrophoresis and inflammatory markers were not included. So in future, Researches on big scale should be done as to explore the exact mechanism of anemia (its type) in obesity, iron profile and inflammatory markers should be evaluated.
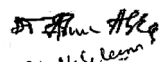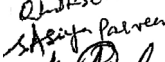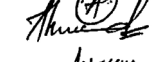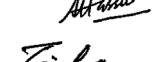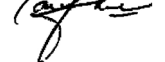
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3	Syeda Asiya Parveen	Data analysis.	
4	Ali Ahmed	Drafting, Editing.	
5	Syed Hafeezul Hussan	Critical review.	
6	Taif Hameed	Drafting, Data Collection.	