

ORIGINAL ARTICLE

The Obesity: A Risk to Iron DeficiencyAma tul Naval¹, Ahsan Ahmad Alvi², Aqsa Liaqat³, Ayesha Nayyar⁴**ABSTRACT****Objective:** To determine association between iron deficiency and obesity in twin cities of Pakistan.**Study Design:** Observational Cross sectional Study.**Place and Duration of Study:** The study was carried out in Islamic International Medical College and Railway General Hospital Rawalpindi. The duration of the study was one year (April 2017 to March 2018).**Materials and Methods:** Eighty obese, eighty overweight and eighty normal weight healthy individuals were recruited. 5ml blood was collected. Blood complete picture, serum iron levels, total iron binding capacity, transferrin saturation and serum ferritin levels were performed. Data was collected and analyzed on SPSS version 21.**Results:** Sixty seven (84%) obese adults had iron deficiency out of which 38 (48%) had iron deficiency state and 29 (36%) iron deficiency anaemia. 64 (80%) overweight adults had iron deficiency out of which 46 (57%) had iron deficiency state and 18 (23%) iron deficiency anaemia. 50 (62%) normal weight had iron deficiency among those 33 (41%) had iron deficiency state and 17 (21%) had iron deficiency anaemia. Serum Iron and Transferrin Saturation were significantly low in overweight and obese with a p-value of <0.001. Serum Ferritin was significantly in higher diagnostic range among overweight and Obese than the normal weight with a p-value <0.001.**Conclusion:** Iron deficiency and iron deficiency anaemia have higher prevalence among obese individuals.**Key Words:** Ferritin, Iron Deficiency Anemia, Iron Deficiency State, Obese, Overweight, Transferrin Saturation.**Introduction**

Obesity is on surge in developing countries. This is due to rapidly changing lifestyle and dietary habits. There is increasing burden of both obesity and under nutrition in these nations.¹ Worldwide obesity has tripled since 1975. WHO states that 13% of the world population is obese which comprises around 0.65 billion people.² In Pakistan 5.4% adult population is obese. It indicates that around 7.2 million people are obese. Pakistan ranks 20th in respect to high number of obese population in world.³ Obesity is associated with a number of morbid conditions which include

Diabetes, Hypertension, Cardiovascular disorders, Liver diseases, Psychological disorders and cancers.⁴

On the other hand iron deficiency is a common health problem worldwide.⁵ Although iron deficiency is a problem considered linked with under nutrition, it is also considered present in obese individuals. Iron deficiency state is a condition in which there are decreased iron stores in the body but hemoglobin levels are normal for the age and sex of the individual. Iron deficiency anaemia is a condition in which lack of iron stores in the body lead to hemoglobin levels below normal for the age and sex of the individual.^{6,7} Iron deficiency results in a number of health problems. These include impairment of cognitive abilities and memory, stunted growth and development in children, increased risk to pregnancy and related complications which include prematurity and fetal growth retardation, a fall in work capacity and increased risk to cardiovascular disorders.^{8,9} Prevalence of anaemia in Pakistan is 30%. Half of this anaemia is due to iron deficiency.⁵

Amongst causes of iron deficiency anemia; inadequate diet, malnutrition, increased demand in growing children and females during reproductive

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Funding Source: NIL; Conflict of Interest: NIL

Received: May 29, 2018; Revised: January 07, 2019

Accepted: February 18, 2019

period of life, increased blood loss in old males and postmenopausal females are well documented.^{10,14} The association of obesity with iron deficiency anaemia is well documented in various studies conducted in developed nations.¹⁵ The data available on this subject in developing countries does not highlight this strong association of obesity with iron deficiency.¹⁵ Scanty data is available from the developing countries. To the author's knowledge, no such study has been conducted in Pakistan. This study has been conducted to determine association between obesity and iron deficiency in our set up where both obesity and iron deficiency are common.

Materials and Methods

It was an observational cross sectional study. The study was carried out in Islamic International Medical College and Railway General Hospital Rawalpindi. The duration of the study was one year (April 2017 to March 2018). It included 80 obese (BMI 30 and above), 80 overweight (BMI 25-29.9) and 80 normal BMI individuals (BMI 18.5-24.9). The sampling technique was Non Probability Convenient sampling. The study was approved by the Ethical Review Committee Riphah International University Islamabad. Inclusion Criteria included: Apparently healthy individuals with age between 18-65 years. Exclusion Criteria included: Subjects with BMI below 18.5 kg/m². Subjects suffering from any bleeding disorders. Pregnant and lactating women and individuals having any acute or chronic infection or inflammatory disorder.

Healthy adults were recruited which included patient attendants in the wards and OPD, nursing staff, nursing students, lab technicians, technician students, workers and doctors. Informed consent was taken. Demographic Data was collected which included name, age gender and ethnicity. Each individual was allotted a separate number. Height of the individuals was measured in centimeters and converted into meters. The weight was measured in kilograms. BMI was measured using the formula: Weight in kilograms/ height in meter square. Detailed medical history was taken regarding drug intake, blood loss, pregnancy, lactation, thyroid disorder, and to rule out any acute or chronic disease in the individuals.

Subjects were seated comfortably on a chair. 5ml blood was collected from ante cubital vein by

applying the tourniquet 3 to 4 inches above the puncture site. After cleaning the area with 70% isopropanol in circular motion from inward to outward. The needle was inserted at the arm surface at 15-30 degree angle. Tourniquet was removed and sample bottles were filled. Needle from the patient arm were removed and gauze was placed on puncture site. 2ml blood was filled in EDTA vial and 3ml in serum vials. CBC was performed immediately. Serum samples, after centrifugation at 4000gx for 10 minutes, were stored at -20°C until tested.

Blood counts and red cell indices were measured on Sysmex XP100 from EDTA anti coagulated blood using StromatolyserWR (500ml) and cell pack (20ml) provided by Sysmex Asia Pacific Pte Ltd. It was stored at 2-8 °C.

Serum Iron was quantitatively measured by Ferene Method on MERCK micro lab 300, Netherlands using Human kits. TIBC was quantitatively measured by Precipitation Method on MERCK micro lab 300, Netherlands using Randox kits. Serum Ferritin was quantitatively measured by ELISA technique on 96 Plate Reader, Netherlands using Human Kits.

Statistical analysis was done using SPSS version 21. Mean \pm SEM were given for quantitative variables. Chi-square was used for analyzing Iron deficiency state and Iron deficiency anaemia in three BMI groups and between genders. One way ANOVA (Analysis of Variance) and independent sample t test were used to analyze Serum Iron, Serum TIBC, Serum Ferritin and Serum Transferrin saturation. The percentage and number of individuals were calculated using cross tabs. A *p* value of less than 0.05 was considered significant.

Results

A total of 240 individuals were studied. 80 individuals were obese, 80 were overweight while 80 were in normal BMI range. There were 60 (75%) females in each group and 20 (25%) males in each BMI group. There were 20 individuals with age range between 18-29 years, 24 in the range of 30-41years, 18 in range of 42-53 years and 18 in range of 54-65 years in each group.

The mean hemoglobin, serum iron, serum TIBC, transferrin saturation and serum ferritin in all groups are shown in the Table I. The frequency of iron deficiency, iron deficiency state and iron deficiency anaemia are given in Table I.

Table I: Comparison of the Frequency of IDA and IDS in different BMI Groups

| BMI Kg/m ² | Iron Deficiency State | | Iron Deficiency Anemia | | Total |
|-----------------------|-----------------------|----------|------------------------|----------|-------|
| | Number | P Value* | Number | P Value* | |
| 18.5-24.9 | 33(41%) | | 17(21%) | | 80 |
| 25.0-29.9 | 46(57%) | 0.04 | 18(23%) | 0.8 | 80 |
| 30 and above | 38(48%) | 0.426 | 29(36%) | 0.036 | 80 |

P-value versus 18.5-24.9

33 out of 80 were in iron deficiency state and 17 were in iron deficiency anaemia in normal weight individuals. Among overweight there was a significantly higher number of individuals in iron deficiency state with a p value of 0.04. In obese individuals the number of subjects with iron deficiency anaemia was significantly higher with a p value of 0.03. (Table)

Hemoglobin level <12 in females and <13 in males represent anaemia. Normal serum iron is 37-145ug/dl in females and 59-148ug/dl in males and TIBC is 259-388ug/dl (46.4-69.5umol/l). Normal Transferrin Saturation is 20% to 50%. Serum ferritin ranges from 30-300ng/ml in normal individual. In setting of inflammatory disease, ferritin levels below 100ng/ml represent absolute iron deficiency.

Mean serum iron was significantly lower in the obese group with a p value of <0.001. Serum transferrin saturation was significantly low in the overweight and obese groups with a p value of <0.001. Serum ferritin levels were significantly on the higher side of diagnostic range in overweight and obese individuals with a p value of 0.002 and <0.001 respectively. Hemoglobin and TIBC were not significantly affected in overweight and obese subjects. (TableII)

Table II: Comparison of Hemoglobin and Serum Iron profile in three BMI Groups

| Parameters | | BMI: 18.5-24.9 | BMI:25-29.9 | P value | BMI:30and above | P value |
|----------------------------|------|----------------|--------------|---------|-----------------|---------|
| Hemoglobin (g/dl) | Mean | - | 12.98 ±1.71 | 0.20 | 13.00 ±1.78 | 0.56 |
| Serum Iron (ug/dl) | Mean | 69.730 ±35.5 | 54.540 ±34.4 | 0.17 | 44.28 ±35.50 | <0.001 |
| Serum TIBC (ug/dl) | Mean | 299.8 ±99.96 | 305.7 ±94.63 | 0.27 | 312.68 ±90.9 | 0.068 |
| Transferrin Saturation (%) | Mean | 27.80 ±20.29 | 18.83 ±11.89 | <0.001 | 15.04 ±7.85 | <0.001 |
| Serum Ferritin (ng/ml) | Mean | 28.03 ±40.90 | 30.06 ±62.88 | 0.002 | 70.71 ±90.79 | <0.001 |

Discussion

In the present study, Iron deficiency state was present in 41% normal individuals, 57% overweight and 48% obese. Iron deficiency state was

significantly higher among overweight individuals with a p value of 0.04. A study conducted on 321 children and adolescents showed that iron deficiency was higher among overweight and obese children with a p value of <0.001.¹⁶ Another study conducted on Sudanese women showed that iron deficiency increased with the increasing BMI in pregnant women with a p value of 0.015.¹⁷

Iron deficiency Anaemia was 21%, 23% and 36% among normal, overweight and obese individuals, respectively in this study. The p value was 0.036 showing significant increase with increasing BMI. A study conducted on 421 adolescent Iranian girls showed that iron deficiency anaemia was significantly higher among overweight and obese girls than normal weight. The frequency was 27%, 28% and 36% among normal, overweight and obese girls respectively.¹⁸ Another study conducted on 118 obese and 57 normal weight children showed that iron deficiency anaemia was significantly higher among obese children with a p value of <0.001.¹⁹

In our study mean serum iron and transferrin saturation were significantly lower in overweight and obese individuals while serum ferritin levels were significantly on the higher side of diagnostic range. Low serum iron levels in obese were first reported when Wenzel et al found significantly low serum iron levels in obese patients.²⁰ A study conducted on 234 obese and 172 non obese adolescents in Washington DC showed that high BMI was associated with significantly low serum Iron levels with a p value of 0.002 while serum ferritin was higher obese with a p value of 0.009.²¹ Low transferrin saturation is mentioned in a number of studies conducted on obese individuals. A study carried out on 35 obese and 35 non obese children showed that obese children had significantly low transferrin saturation than non-obese children with a p value <0.05.²² Another study conducted on 50 obese and 50 non obese Egyptian children showed that serum iron and transferrin saturation was significantly low while serum ferritin levels were significantly higher among obese children.²³ Other studies conducted on obese individuals in developed countries have also shown similar results.^{24,25}

Higher levels of serum ferritin can be explained by the fact that ferritin is an acute phase reactant and its levels rise in settings of inflammation.²⁶ Adipose

tissue releases inflammatory cytokines including interleukin-1, IL-6 and TNF.²⁷ It creates a proinflammatory environment resulting in increased levels of ferritin in circulation.²⁸

Iron deficiency in obesity can be explained by a number of factors which include dilutional hypoferrremia, increased basal losses of iron, intake of iron poor diets and decreased absorption in obese individuals due to higher hepcidin levels.^{24,27,29}

It is evident from the present study that iron deficiency state is highly prevalent among obese and overweight individuals and should be focused and corrected at an earliest to save the patient from undue complications. It is a known fact that complications set in iron deficiency state before progression to the stage of iron deficiency anaemia. These include impairment of cognitive abilities and memory functioning as well as result in stunted growth in children.^{6,26}

The importance of obesity is almost parallel to other causes of iron deficiency anaemia as mentioned earlier. To overlook this important cause of iron deficiency will result not only in aggravation of signs and symptoms of iron deficiency anaemia but also will add to failure in achievement of satisfactory management of this common ailment of our society. The diagnostic workup of iron deficiency should include complete iron profile with a view to consider raised diagnostic value of serum ferritin levels in obese as compared to normal individuals. The management should include iron supplementation along with weight reduction.^{30,31}

Further studies can be conducted including C-reactive proteins and serum hepcidin levels to better understand the pathophysiology of iron deficiency in obesity.

Conclusion

Iron deficiency is significantly associated with obesity. It should be considered in all age group obese and overweight patients visiting OPD clinics or hospital departments with or without symptoms of anaemia.

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