CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

SJIF Impact Factor: 7.187
http://doi.org/10.5281/zenodo.4314158

Avalable online at: http://www.iajps.com *Research Article*

STUDY TO DETERMINE THE ASSOCIATION BETWEEN IRON DEFICIENCY AND OBESITY

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Article Received: October 2020 **Accepted:** November 2020 **Published:** December 2020

Abstract:

Background: *Obesity and iron deficiency anemia are major health problems that are exacerbated in Egypt, especially in women.*

Aim of the study: *The aim of the study was to evaluate iron levels in obese Egyptian women in comparison with females of normal body weight.*

Place and Duration: *In the Medicine Unit-II of Sir Gangaram Hospital, Lahore for one-year duration from August 2019 to August 2020.*

Patients and Methods: *Forty-four obese adult women and 44 healthy, normal-weight women were included in the study as controls. All were tested for iron profile and CRP using a semi-quantitative rapid latex agglutination test.*

Results: *the group of patients in this study showed significantly lower serum Fe and TSI levels than the control group, while the ferritin was higher in the patients than the control group. Comparison between the three obesity groups showed that Grade III patients had the lowest median serum iron and the highest median TIBC and ferritin values, but no statistically significant differences were found between the three patient groups (P> 0.05). Our results showed that 70.4% of patients were CRP positive with a positive correlation between CRP and BMI.*

Conclusions and recommendations: *obesity is a low-inflammatory disease that affects the iron profile and increases CRP. In addition, a larger number of cases are recommended to analyze the exact mechanism of iron deficiency anemia in obese women.*

Key words: *iron deficiency, anemia and obesity.*

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Please cite this article in press Muneeba Bint-E-Saeed et al, ***Study To Determine The Association Between Iron Deficiency And Obesity.,*** *Indo Am. J. P. Sci, 2020; 07(12).*

INTRODUCTION:

Iron deficiency remains the most common nutrient deficiency and cause of anemia worldwide. Populations in developing countries, premenopausal women, pregnant women, children, vegetarians and frequent blood donors are heavily affected by iron deficiency due to low iron intake, insufficient iron bioavailability, increased iron requirements for growth and development, iron loss and changes in blood volume. The WHO has recognized obesity as a disease that is common in both developing and developed countries. Overweight and obesity are so common these days, and thus replace the more traditional public health problems (related to nutrition and infectious diseases), which are among the most important causes of poor health.

Obese people who develop ID have an increased health burden. Initially iron-deficient, ID can progress to iron-deficient erythropoiesis, eventually leading to iron deficiency anemia (IDA). The mechanism explaining iron status and obesity remains unclear; this may be due to a lower iron intake and / or an increased iron requirement in overweight people. Moreover, chronic inflammation and the increased production of leptin characteristic of obesity increase the secretion of hepcidin from the liver, which, together with hepcidin produced by adipose tissue, can reduce the absorption of iron from food. The purpose of this study was to evaluate iron levels in obese Egyptian women compared to females of normal weight.

PATIENTS AND RESULTS:

This study was conducted on 44 obese adult women in the Medicine Unit-II of Sir Gangaram Hospital, Lahore for one-year duration from August 2019 to August 2020. The diagnosis of obesity was based on anthropometric measurements (weight, height and BMI, respectively). Participants were classified as Obesity Grade I (if BMI = 30.0 kg / m2 to 34.9 kg / m2), Obesity Grade II (if BMI = 35.0 kg / m2 to 39.9 kg / m2) and Grade III (if BMI ≥ 40.0 kg / m2) m2) (4). Patients were excluded if they were on iron therapy or were taking dietary supplements or vitamins containing iron, received non-steroidal anti-inflammatory drugs 48 hours prior to blood sampling, had a history of blood donation or transfusion, and had chronic or hematological or menstrual or postnatal disease.

All patients underwent:

1- Weight measurement with digital scale with light clothing and no shoes.

2- Measure height by placing on a fixed height measuring device

3- BMI is calculated by dividing a person's weight in kilograms by the square of the person's height in meters (kg / m²). The normal range is 18.5-24.9, while overweight is 25-29.9 and obese 30 years and older. Complete blood count (CBC) using an automatic blood count (Diagon D-CELL-60) with Leishman stained peripheral blood smears.

4- Measurement of C-reactive protein (CRP) using a semi-quantitative rapid latex agglutination kit (Omega Diagnostics, Scotland, UK).

5- Measurement of serum iron and unsaturated iron binding capacity (UIBC) with an automated analyzer (BT 1500), (Biotecnica Instruments SPA, ViaLicenza 18.00156 Rome (Italy). 6- Measurement of serum ferritin with a kit, Enzymelinked Immunosorbent Assay (ELISA), (ChemuxBioScience, USA).

Sample collection and storage:

Venous blood (6 ml) was taken in each case by sterile venipuncture and divided into 3 ml in an EDTA tube for CBC analysis and 3 ml in a serum separation tube. The serum was divided for determination of iron, UIBC, ferritin, and CRP. The serum for analysis was stored in Eppendorf at (-20). It was then thawed at room temperature during the analysis.

Iron profile measurement:

Serum iron and UIBC were measured using a diagnostic reagent for the quantification of iron and UIBC in vitro in human serum on photometric systems. The expected normal value of serum iron is 50-170 µg / dL. TIBC was calculated from the following formula: TIBC (µg / dL) = UIBC (µg / dL) + iron (µg / dL). Expected Normal Value for TIBC: 274–497 µg / dL. Serum ferritin was measured spectrophotometrically at 450 nm absorbance. The expected normal value was 13-150 ng / ml.

C-reactive protein:

Performed with the rapid latex agglutination test for qualitative screening and semi-quantitative serum CRP determination. Expected Normal CRP Value: <6.

Statistical methods:

The data was coded and entered with the SPSS version 15 statistical package. The data was summarized with descriptive statistics: mean, standard deviation and median values for quantitative variables and number and percentage for qualitative values. Statistical differences between the groups were tested using the Chi-square test for qualitative variables, the t-test for the independent sample and ANOVA (analysis of variance) with the post Hoc Bonferroni test for quantitative variables with a normal distribution, while the non-parametric Mann Whitney test and the

Kruskal-Wallis test for quantitative variables that are not normally distributed. Correlations were performed to test linear relationships between the variables. P values less than or equal to 0.05 were considered statistically significant, while p values less than or equal to 0.01 were considered highly significant.

RESULTS:

It was a follow-up study carried out in 88 adult women; 44 obese adult patients ranged from 18 to 53 years old, with a mean age (31.55 ± 9.83) years and a mean BMI (38.81 ± 4.79) kg / m² and 44 healthy people with normal weight 18-50 years of age with mean age (25.41 ± 7.40) years and mean BMI (21.58 ± 2.19) kg / m². CRP was measured in all patients. The percentage of CRP positive and negative in patients was 70.45% and 29.54%, respectively. According to BMI, patients were classified as obesity I, II and III degree with the percentage of 20.4%, 38.6% and 40.9%, respectively.

Comparative studies:

When comparing the anthropometric measurement between the groups of patients and the control group, highly statistically significant differences were found between the two groups in terms of body weight and BMI (p <0.001) (Table 1).

Table 1: comparison between the patients group and the control group regarding anthropometric measurements and CBC parameters.

Parameters		Patient group n = 44	Control group n = 44	Test of sig.(t)	P value
Weight (kg)	Mean ± SD	94.30 ± 12.04	53.09 ± 7.19	18.56	0.001
	Range	66.0 – 120.0	31.50 – 66.50		
Height (cm)	Mean ± SD	156.59 ± 5.97	155.32 ± 22.13	0.36	0.715
	Range	144.0 – 171.0	150.2 ± 169.0		
BMI (kg/m^2)	Mean ± SD	38.81 ± 4.79	21.58 ± 2.19	21.69	< 0.001
	Range	30.0 – 49.18	18.0 – 25.0		
WBC (x 10^9/L)	Mean ± SD	6.99 ± 1.77	6.08 ± 1.86	2.33	0.022
	Range	4.20 – 11.10	3.20 – 10.0		
RBC (million/µl)	Mean ± SD	4.46 ± 0.40	4.30 ± 0.37	1.84	0.069
	Range	3.61 – 5.42	3.44 – 5.42		
Hb (g/dl)	Mean ± SD	11.63 ± 1.03	12.59 ± 0.57	-5.42	< 0.001
	Range	8.70 – 13.70	12.0 – 14.0		
MCV (fl)	Mean ± SD	79.26 ± 5.84	83.83 ± 4.37	-4.14	< 0.001
	Range	61.40 – 91.20	74.50 – 93.60		
MCH (pg)	Mean ± SD	26.20 ± 2.38	28.66 ± 2.39	-4.83	< 0.001
	Range	19.30 – 30.70	24.40 – 33.60		
RDW (%)	Mean ± SD	15.88 ± 0.88	14.85 ± 0.39	7.02	< 0.001
	Range	14.30 – 19.00	14.10 – 15.60		
Platelets (x 10^9/L)	Mean ± SD	278.59 ± 58.34	246.73 ± 58.56	2.55	0.012
	Range	160.0 – 417.0	150.0 – 400.0		

Comparative studies between the patient group and the control group on CBC parameters showed that Hb, MCV and MCH were significantly lower in the patient group than in the control group (P <0.001), but the RDW was significantly higher in the patient group than in the control group (P < 0.001) (Figure 1).

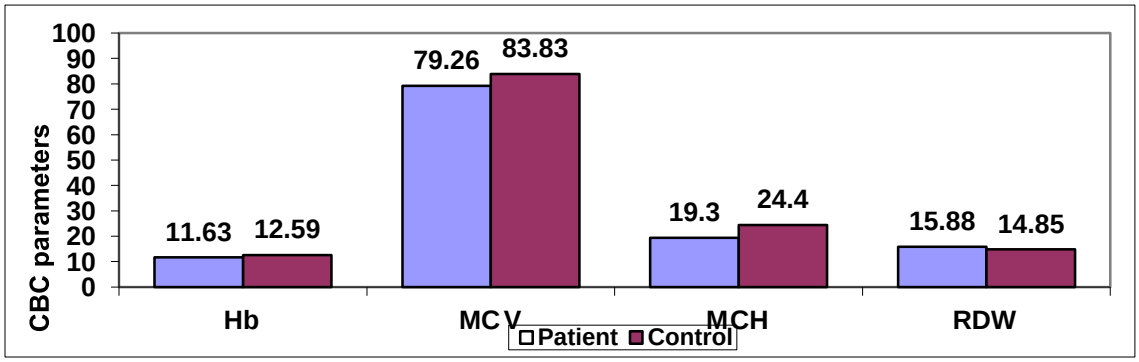

Figure 1: comparison between patients group and the control group regarding CBC parameter

Also, the values of white blood cells were significantly higher in the group of patients than in the control group (p = 0.022), and the number of platelets was significantly higher in the group of patients than in the control group (p = 0.012) (Table 1). As for the iron profile results, the group of patients showed significantly lower Fe and TSI than the control group (P <0.001). Ferritin was higher in the patient group than in the control group, but was not statistically significant (P = 0.446). TIBC did not show statistically significant differences between the patient and the control group (P = 0.885) (Table 2) (Fig. 2).

Iron profile		Patient group N = 44	Control group N = 44	Test of sig.	P value
Fe (µ/dl)	Median	30.55	57.3	-6.897	< 0.001
	$25^{th} – 75^{th}$	14.42 – 44.37	53.15 – 62.03		
TIBC (µ/dl)	Median	403.95	430.80	-0.184	0.885
	$25^{th} – 75^{th}$	383.8 – 500.1	386.85 – 520.62		
TSI (%)	Median	6.11	13.42	-0.491	< 0.001
	$25^{th} – 75^{th}$	3.06 – 11.77	11.02 – 15.91		
Ferritin (ng/ml)	Median	20.83	15.85	0.766	0.446
	$25^{th} – 75^{th}$	5.64 – 37.55	14.65 – 19.65		

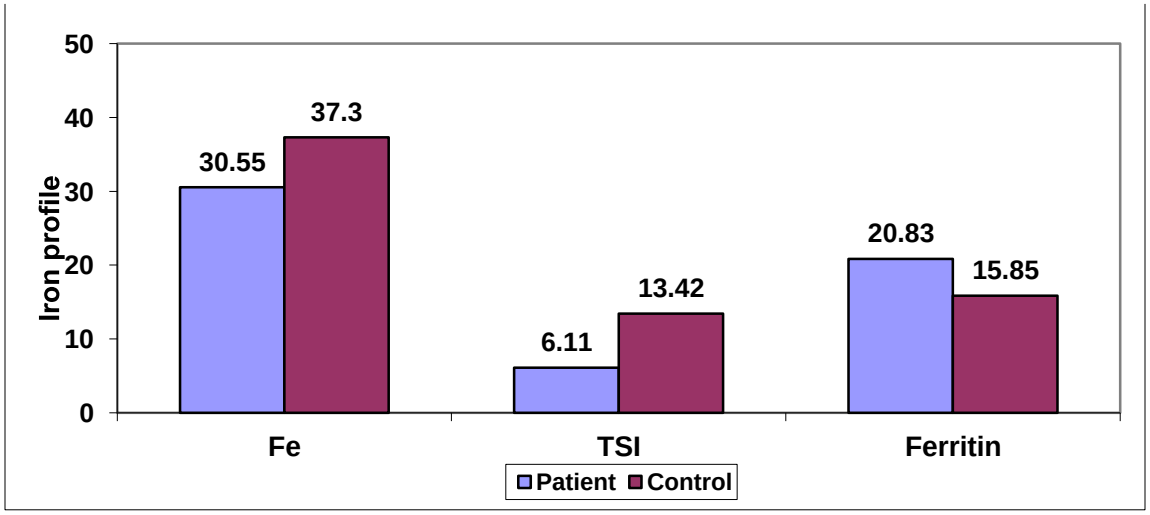

Figure 2: comparison between the patients group and the control group regarding iron profile

The comparison between the three obesity groups showed no statistically significant differences between the groups for all CBC parameters (P> 0.05). Regarding iron profile, a comparison between the

three obesity groups showed that Grade III patients had the lowest median serum iron than Grades I and II, and also showed the highest median TIBC and ferritin values than Grades II and I, however these results did not show statistically significant differences between the three groups of patients (P> 0.05). The comparison also showed that the median CRP in patients with grade III was higher than those in grade II and I with no statistically significant difference (p = 0.111).

Correlation studies:

Age was directly correlated with BMI (P = 0.03). BMI showed a positive correlation with WBC, RBC, Hb, TIBC and ferritin, and a negative correlation with platelets, Fe and TSI, but no significant difference (p> 0.05). CRP was positively correlated with BMI, but no significant difference (P => 0.05).

DISCUSSION:

The Egyptian Health Study (EHIS) found that 26% of women of childbearing age (15-59 years) were overweight and 50% were obese. The prevalence of overweight and obesity reached alarming levels, obesity increased directly with age, from 15% in women aged 15-19 to 76% and more in women aged 45-59. Urban women were more obese than rural women, and the proportion classified as obese ranged from 36% in rural Upper Egypt to 56% in urban Lower Egypt. The results of this study showed a very significant association between obesity and age with an average age of 31.5 years. This was consistent with Cepeda-Lopez et al. Who found that the mean age of obese women in the study was 34.9. Similarly, the NNI found that the prevalence of obesity increases with age, with obesity occurring more frequently in women in their 20s to 30s, reaching a peak at 50 years of age. This study showed low Hb values in obese patients with a mean of 11.63, in contrast to the results of Ceped-Lopez et al. And Yanoff et al. who in their studies reported normal Hb values with a mean of 13.7 and 13.5, respectively, in obese patients. Our study found that obese women had low serum iron and TSI levels than the control group. On the other hand, serum ferritin, TIBC and CRP levels were higher in obese patients than in the control group. This was in agreement with Yanoff et al. Who reported that an increase in BMI affected iron levels in obese patients, showing low serum iron and TSI values and high ferritin and CRP values in obese patients than in those of normal body weight. In this study, a negative correlation was found between BMI and both serum iron levels and TSI, with no significant difference. These results were consistent with the results of Lecube et al. Showed a negative correlation between BMI and serum iron levels and TSI. A positive correlation was found between BMI and ferritin, according to Yanoff et al. Who reported that ferritin in obese women was positively correlated with BMI, but was negligible with it. In turn, Lecube et al. reported that there was no difference in serum ferritin levels between normal-weight and obese patients.

Other studies have associated obesity with low levels of systemic inflammation. In addition, others have shown that CRP levels drop significantly after significant weight loss. This decrease indicated that fat mass plays an important role in the production of CRP. This also agreed with Gartner et al. which found that inflammation was strongly associated with obesity and increased dramatically with BMI with incidence (20.1%, 37.6%, and 68.4%, respectively, in healthy, overweight and obese women; P <0.0001) . Our study found that approximately 75.67% of obese women with low serum iron levels were CRP positive compared with 42.8% of normal serum iron women who were positive for CRP. This was in agreement with Tussing-Humphreys et al, who concluded that greater obesity was associated with lower fractional iron absorption in humans, regardless of iron levels. Also, this relationship was consistent with Cepeda-Lopez et al. who found that CRP levels were higher in obese women and children and positively associated with BMI and negatively with iron status.

The diagnosis of inflammatory ID in obese women may be overlooked if clinicians rely heavily on false-normal ferritin levels, which are likely increased by chronic inflammation rather than iron overload. The exact mechanisms of the obesity-induced inflammation-induced effect on serum iron remain unclear.

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