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ORIGINAL RESEARCH

A Study of Serum Ferritin in Metabolic Syndrome

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ABSTRACT

Background:The present study was done to determine the association of serum Ferritin in Metabolic Syndrome as well as to determine the relation between individual component of metabolic syndrome and number of components metabolic syndrome and plasma ferritin.

Materials and Methods: It was a Cross-sectional study. The study was carried out at NRI Medical College & Hospital, CHINAKAKANI, GUNTUR. The study was included Metabolic syndrome patients diagnosed as per NCEP (National Cholesterol Education Program) ATP III (Adult Treatment Panel III) (2001) attending the NRI medical college and Hospital during the study period from March 2021 to March 2022. It is a Correlational clinical single group study with 102 patients.

Results: In the present study, the mean age group of the study population was 57.38 ±8.05. The majority of the study participants belonged to the 51–60 years age group, i.e., 40.2%, followed by 36.3% in 61–70 years age group. In the present study, the majority of the study population were male, i.e., 62.7% and females were 37.3%. In the present study, the majority of the male and female belonged to 51- 70 years age group. In the present study, overweight was 42%, and obese was 58%. In the present study, the majority, i.e., 98.4%, had a waist circumference of >90 cm, and among the female majority, i.e., 94.7% had a waist circumference of >85cm. In the present study, 87.3% had systolic Blood pressure >130 mmHg, and 84.3% had Diastolic Blood pressure >85 mmHg. In the present study, 62.7% were Hypertensives and were taking regular medications. 78.4% of the study population were diabetics. The mean duration of diabetes in the present study was 2.11 ± 0.84. 18.6% had a duration of diabetes <3 years, 3-6 years in 37.3%, and 22.5% had a period being >6 years. 22.5% had 1+ urine albumin, 2.9% with 2+ urine albumin. 74.5% didn't show any albumin in urine analysis. 61.8% had no sugar in the urine. Trances of sugar in urine were identified in 38.2%. Based on the ATP III criteria, metabolic syndrome was classified. 20.6% had 3 components, 28.4% had 4 components, majority i.e. 51% had 5 components identified. In the present study, a statistically significant association was observed between metabolic syndrome components and PPBS, Total cholesterol, Triglycerides, HDL, LDL as the p-value calculated to be <0.05. In the present study, the mean serum ferritin levels were 126.89 ± 51.77. There was a statistically significant association observed between components of metabolic syndrome and serum ferritin levels as the p-value calculated to be <0.05. In the present study, a significant relation was observed between serum ferritin and waist circumference (r=0.33, pvalue<0.05), Total Cholesterol (r=0.310 pvalue<0.0001), and LDL (r = 0.326; p value <0.0001).

Conclusion: Finally we concluded that, There is a positive association between elevated iron stores, measured by serum ferritin levels, and the prevalence of the metabolic syndrome. Serum ferritin levels correlated with increasing number of components of the metabolic syndrome.

Keywords: Serum Ferritin, Metabolic syndrome, Cholesterol, Diastolic blood pressure, NCEP.

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INTRODUCTION

Metabolic syndrome is an accumulation of several conditions that together increase the risk of a person developing the cardiac atherosclerotic disease, insulin resistance and diabetes mellitus, and vascular and neurological complications such as a stroke. Metabolic derangement becomes a syndrome if the patient has any three of the five criteria, according to the National Cholesterol Education Panel (ATP) III.

1. Abdominal circumference more than 40 inches in males and 35 inches in females
2. Raised triglycerides 150 milligrams per decilitre of blood (mg/dL) or greater
3. Decreased high-density lipoprotein cholesterol (HDL) less than 40 mg/dL in men or less than 50 mg/dL among women
4. Fasting blood glucose of l00 mg/dL or higher
5. Blood pressure values of systolic 130 mm of Hg or higher and diastolic 85 mm of Hg or higher.[1]

Metabolic syndrome has severe implications on an individual's health and healthcare costs. It is needed to identify the rising prevalence of metabolic syndrome in America as through intervention the development of the syndrome can be halted and potentially reversed.[2–4]

Metabolic syndrome, also known as X-Syndrome, insulin resistance, etc., is described by WHO as a pathological disorder characterized by abdominal obesity, insulin resistance, hypertension, and hyperlipidemia. This new non-communicable disease (NCD) has become the main health hazard of the modern world with the successful conquest of communicable infectious diseases globally. Although it began in the Western world, with Western lifestyle spreading across the globe, it has now become a truly global issue. Metabolic syndrome is often more common in some developing countries ' urban populations than in their Western counterparts. The two fundamental causes that spread this disease are the rise in high-calorie-low fiber-fast food intake and the decline in physical activity due to mechanized transportation and sedentary type of leisure time activities. The syndrome feeds on disease spread such as type 2 diabetes, coronary disease, stroke and other impairments.[5]

Metabolic syndrome incidence also matches the prevalence of obesity and type 2 diabetes incidence (one of the MetS outcomes). According to CDC data published in 2017, nearly 30.2 million adults aged 18 years or older or 12.2% of adults in the United States had type 2 diabetes (T2DM). One quarter (23.8 percent) of these people were unaware of diabetes. T2DM incidence increased with age, reaching a high of 25.2% among U.S. seniors (65 years of age or older). Prevalence was about three times higher for prediabetes or MetS. Around one-quarter of adults in the United States have metabolic syndrome.[6]

Asian Indians are at more risk of developing diabetes and cardiovascular disease, and the number of cases is consistently increasing. Recent study data show that about one-third of the urban population in India's major cities has metabolic syndrome.[7]

Iron has an essential role in the normal physiological functions of the human body. Ferritin, one of the vital proteins regulating iron homeostasis, is a widely available clinical biomarker to evaluate the iron status and especially crucial for detecting an iron deficiency. However, pile up evidence has shown that even moderately elevated iron stores represented by high-normal ferritin concentrations- are associated with diabetes.[8]

High levels of ferritin, in the absence of high transferrin saturation, have come in to view during the last years as a common finding in some patients with metabolic syndrome.[9] It reported that increased ferritin levels observed in subjects with metabolic syndrome are related to insulin resistance and fatty liver disease but not with iron overload, determined in liver biopsies by quantitative phlebotomy.[10]

The current study was undertaken to know the relationship between serum ferritin and metabolic syndrome and also to evaluate the components of metabolic syndrome with serum ferritin among the patients with metabolic syndrome as per the criteria of National Cholesterol Education Panel(ATP) III attending NRI medical college and Hospital, Chinakakani, Guntur.

Aims and Objectives of the Study

1) To know the relationship between serum ferritin and metabolic syndrome.
2) To evaluate the relationship between serum ferritin and components of metabolic syndrome.

MATERIALS & METHODS

Study design: Cross-sectional study.

Study area: NRI Medical College & Hospital, CHINAKAKANI, GUNTUR.

Study population: Metabolic syndrome patients diagnosed as per NCEP (National Cholesterol Education Program) ATP III (Adult Treatment Panel III) (2001) attending the NRI medical college and Hospital during the study period from March 2021 to March 2022.

Sample size: 102

Inclusion and Exclusion criteria

Inclusion Criteria:

All patients with metabolic syndrome, as per the criteria of the National Cholesterol Education Panel ATP 3.

Exclusion criteria:

1. Anemic or people who received treatment for anemia in the last three months
2. Persons Who donated blood in the last four months
3. Patients with hemochromatosis
4. Positive inflammatory markers like (CRP> 1mg/dl, WBC> 11,000/cu mm or WBC <3000/cu mm)
5. Patients with hemolyticanemia

Method of Collection of Data:

After fulfilling the inclusion and exclusion criteria, 102 patients diagnosed with metabolic syndrome as per NCEP (National Cholesterol Education Program) ATP III (Adult Treatment Panel III) (2001) attending the NRI medical college and Hospital during the study period were included in the study after taking informed consent.

- A detailed history of the patients
- Clinical examination of the patients

All the patients have undergone the following investigations:

- FBS,
- PPBS,
- Blood urea,
- Serum creatinine,

- Fasting Lipid Profile,
- Baseline ECG,
- CRP,
- Urine routine,
- Complete blood count with peripheral blood smear,
- Fasting serum ferritin levels (single-incubation two-site immunoradiometric assay
- Serum ferritin was estimated by micro-ELISA using human ferritin enzyme immunoassay test with desirable levels in males are 30-300 ng/ml and females 15-200 ng/ml.

Statistical Analysis methods:

Descriptive statistical analysis has used in the present study. Results on continuous measurements presented on Mean ± SD (Min-Max) and effects on categorical measures shown in Number (%). Significance assessed at a 5% level of significance. Analysis of variance (ANOVA) has been used to find the importance of study parameters between three or more groups of patients, and Chi-square/ Fisher Exact test was used to find the significance of the study as mentioned above parameters on categorical scale between two or more groups. 95% Confidence Interval has been computed to see the significant features.

RESULTS

Table 1:Age distribution

Age	Frequency	Percentage
30–40	3	2.9
41–50	19	18.6
51–60	41	40.2
61–70	37	36.3
71–80	2	2.0
Total	102	100.0
Mean±SD	57.38±8.05	

In the present study, the mean age group of the study population was 57.38 ± 8.05. The majority of the study participants belonged to the 51–60 years age group, i.e., 40.2%, followed by 36.3% in 61–70 years age group.

Table 2: Gender distribution

Gender	Frequency	Percentage
Male	64	62.7
Female	38	37.3
Total	102	100.0

In the present study, the majority of the study population were male, i.e., 62.7% and females were 37.3%.

Table 3: Age and Gender distribution

	Male	Female	Total
30-40	0	3	3
41-50	18	1	19
51-60	23	18	41
61-70	23	14	37
71-80	0	2	2

Total	64	38	102

In the present study, the majority of the male and female belonged to 51- 70 years age group.

Table 4: BMI distribution

BMI	Frequency	Percentage
25–29.9	43	42.2
>30	59	57.8
Total	102	100.0

In the present study, overweight was 42%, and obese was 58%.

Table 5a: Wist circumference – Male

Wist circumference	Frequency	Percentage
<90cm	1	1.6%
>90cm	63	98.4%
Total	64	100%

Table 5b: Wist circumference – Female

Wist circumference	Frequency	Percentage
<85cm	2	5.3%
>85cm	36	94.7%
Total	38	100%

In the present study, the majority, i.e., 98.4%, had a waist circumference of >90 cm, and among the female majority, i.e., 94.7% had a waist circumference of >85cm.

Table 6a: SBP distribution

SBP	Frequency	Percentage
<130mmHg	13	12.7%
>130mmHg	89	87.3%
Total	102	100%

Table 6b: DBP distribution

DBP	Frequency	Percentage
<85mmHg	16	15.7%
>85mmHg	86	84.3%

In the present study, 87.3% had systolic Blood pressure >130 mmHg, and 84.3% had Diastolic Blood pressure >85 mmHg.

Table 7: HTN on treatment

HTN on treatment	Frequency	Percentage
Yes	64	62.7%
No	36	37.3%
Total	102	100%

In the present study, 62.7% were Hypertensives and were taking regular medications

Table 8: Duration of Diabetes

Duration of Diabetes	Frequency	Percentage
No	22	21.6
<3 years	19	18.6
3 –6years	38	37.3
>6years	23	22.5
Mean±SD	2.11 ±0.84	

78.4% of the study population were diabetics. The mean duration of diabetes in the present study was 2.11 ± 0.84. 18.6% had a duration of diabetes <3 years, 3-6 years in 37.3%, and 22.5% had a period being >6 years.

Table 9: Urine Albumin

	Frequency	Percentage
1+	23	22.5
2+	3	2.9
Nil	76	74.5
Total	102	100.0

22.5% had 1+ urine albumin, 2.9% with 2+ urine albumin. 74.5% didn't show anyalbumin in urine analysis.

Table 10: Urine sugar

	Frequency	Percentage
0.005	7	6.9
0.01	19	18.6
0.015	7	6.9
0.02	6	5.9
nil	63	61.8
Total	102	100.0

61.8% had no sugar in the urine. Trances of sugar in urine were identified in 38.2%.

Table 11: Biochemical parameters

	Minimum	Maximum	Mean	SD
HB%	12	16.1	13.91	0.96
Totalcount	3500	80600	8383.80	7471.80
MCV	88	103	94.40	3.96
MCHC	3.5	37.5	32.00	5.31
FBS	90	226	150.69	34.20
PPBS	135	387	235.21	64.33
Total cholesterol	150	316	219.82	45.09
Triglycerides	96	268	167.86	27.11
HDL	30	52	40.87	5.69
LDL	70	235	132.54	32.56
BUN	17	66	32.32	9.11
Sr creatinine	0.5	2	1.04	0.31
Sr ferritin	38.6	258	126.89	51.78

Table 12: Metabolic syndrome

	Frequency	Percentage
3Components	21	20.6
4Components	29	28.4
5Components	52	51.0
Total	102	100.0

Based on the ATP III criteria, metabolic syndrome was classified. 20.6% had 3 components, 28.4% had 4 components, majority i.e. 51% had 5 components identified.

Table 13: Biochemical parameters and Metabolic syndrome

	3 Components (n=21)		4 Components (n=29)		5 Components (n=52)		P-value
	Mean	SD	Mean	SD	Mean	SD	
HB%	13.85	1.1	14	1.02	13.89	0.87	>0.05
TCincells	8467.6	1473.91	7095.9	2023.64	9068.3	10297.4	>0.05
MCV	95.19	4.24	94.24	4.15	94.17	3.78	>0.05
MCHC	31.7	6.6	33.03	1.78	31.54	6.01	>0.05

The statistical test used: ANOVA

Table 14: Lipid profile and Metabolic syndrome

	3 Components (n=21)		4 Components (n=29)		5 Components (n=52)		P-value
	Mean	SD	Mean	SD	Mean	SD	
FBS	160.67	41.73	157.55	30.71	142.83	31.38	>0.05
PPBS	258.76	76.88	254.97	68.24	214.67	49.42	<0.05*
Cholesterol	194.57	33.64	217	45.99	231.6	44.86	<0.05*
Triglycerides	151.71	19.4	158.59	31.48	179.56	21.65	<0.05*
HDL	43.48	6.95	42.34	5.3	39	4.71	<0.05*
LDL	116.67	31.07	130	28.9	140.37	33.05	<0.05*

*Statistically significant; ANOVA test used

In the present study, a statistically significant association was observed between metabolic syndrome components and PPBS, Total cholesterol, Triglycerides, HDL, LDL as the p-value calculated to be <0.05.

Table 15: Serum ferritin levels and Metabolic syndrome

Metabolic Syndrome	Mean	Std. Deviation
Fourcomponents	100.72	38.72
Fivecomponents	126.52	52.24
Sixcomponents	137.67	53.13
Overallmean	126.89	51.77
Ftest:4.03,df=2,P-value<0.05*,Statisticallysignificant		

In the present study, the mean serum ferritin levels were 126.89 ± 51.77. There was a statistically significant association observed between components of metabolic syndrome and serum ferritin levels as the p-value calculated to be <0.05.

Table 16: Correlation of serum ferritin with each component in metabolic syndrome

Correlation	Variable	Correlation coefficient (r)	P-value
SerumFerritin	BMI	0.139	>0.05
	Waist circumference	0.335	<0.0001*
	SBP	0.17	>0.05
	DBP	-0.05	>0.05
	FBS	0.104	>0.05
	PPBS	0.094	>0.05
	Total Cholesterol	0.310	<0.0001
	Triglycerides	0.143	>0.05
	HDL	-0.15	>0.05
	LDL	0.326	<0.0001
	BUN	-0.042	0.67
	Serum Creatinine	0.017	0.86

In the present study, a significant relation was observed between serum ferritin and waist circumference (r=0.33, p-value <0.05), Total Cholesterol (r=0.310 p-value <0.0001), and LDL (r = 0.326; p-value <0.0001).

DISCUSSION

Agedistribution

In the present study, the mean age group of the study population was 57.38 ± 8.05. The majority of the study participants belonged to the 51–60 years age group, i.e., 40.2%, followed by 36.3% in 61–70 years age group.

Present study	57.38 ±8.05
ArunKumaretal,[11]	47.93±12.03
Sudhakaretal,[12]	56.13 ±0.9

Majority of the metabolic syndrome risk factors were more prevalent in the older than younger adults; however, it was interesting to note that the sex differences in the prevalence of the various metabolic syndrome factor combinations were primarily abolished in older adults

Gender distribution

In the present study, the majority of the study population were male, i.e., 62.7% and females were 37.3%.

Cohen et al,[13] in their study reported that a cross-sectional sample of subjects with a healthy BMI showed male gender to be a self-sufficient risk factor for all components of the MetS, apart from the low HDL cholesterol risk factor that was found to be higher in women.

Tian et al. reported that Male adults and old females had the highest risk of getting MetS. More diversified diet decreased MetS risk for young female but increased the risk for male adults and old female.[14]

Age and Gender distribution

In the present study, the majority of the male and female belonged to 51- 70 years age group.

A study by Hildrum et al,[15] reported Prevalence of IDF-defined metabolic syndrome was 29.6% (28.8 to 30.5:95% CI), compared to 25.9% (25.0 to 26.7:95% CI) using the 2005 ATP III criteria. The prevalence of IDF-defined MetS increased from 11.0% in the 20-29 years age

group to 47.2% in the 80years-89 years group in males, and from 9.2% to 64.4% for females in the corresponding age groups. Among men and women aged >or=60 years, the IDF criteria classified 56.7% and 75.0%, respectively, as having abdominal obesity, and 89.3% and 90.9%, respectively, as being hypertensive.

BMI distribution

In the present study, overweight was 42%, and obese was 58%. The mean BMI of the present study was 30.25 ± 1.77.

Waist circumference

In the present study, the majority, i.e., 98.4%, had a waist circumference of >90 cm and among the female majority, i.e., 94.7% had a waist circumference of >85cm.

Present study	100.05±6.86
Rameshetal,[16]	IncreasedWaist circumferencein 58.82%
Maitietal,[17]	92.3±7.4
Sivashankarietal,[18]	95.6±5.2
PreetiSharmaetal,[19]	99.11±6.72

SBP and DBP distribution

In the present study, 87.3% had systolic Blood pressure >130 mmHg, and 84.3% had Diastolic Blood pressure >85 mmHg.

Present study	**SBP**	**DBP**
	148.62 ± 14.60	93.02 ± 8.91
Zafaretal,[20]	126±16.95	78.16±10.82
Maitietal,[17]	135.4±6.9	85.1±5.01
Sivashankarietal,[18]	135±11	88 ±7
Preetisharmaetal,[19]	146.59±14.85	92.22±10.29

HTN on treatment

In the present study, 62.7% were Hypertensives and were taking regular medications.

Duration of Diabetes

78.4% of the study population were diabetics. The mean duration of diabetes in the present study was 2.11 ± 0.84. 18.6% had a period of diabetes <3 years, 3-6 yearsin 37.3%, and 22.5% had duration being >6 years.

Urine Albumin

22.5% had 1+ urine albumin, 2.9% with 2+ urine albumin. 74.5% didn't show anyalbumin in urine analysis.

Urine sugar

61.8% had no sugar in the urine. Trances of sugar in urine were identified in 38.2%.

Biochemical parameters

Biochemical parameters	Mean FBS
Present study	150.69

Sivashankarietal,[18]	178.2±66.1
Maitietal,[17]	126.0±11.2
Zafaretal,[20]	82.58±26.68

Classic risk factors, such as abnormal oxidized LDL-C, adiponectin, and CRP levels, display a marked association with the metabolic syndrome.

Therefore, the diagnosis of the MetS identifies patients at high risk of cardiovascular disease because it serves as a marker for many of the non-classic risk factors.

For example, those individuals with the MetS may have qualitative lipid abnormalities in the absence of elevated LDL-C, the primary goal of lipid-lowering therapies in the current National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) guidelines. From a clinical perspective, it reasonable to manage the MetS by diagnosing and treating its components.

Small, dense LDL particles (i.e., oxidized LDL-Cholesterol) have been associated with hypertriglyceridemia, low serum HDL-C, and diabetes, and have higher atherogenic potential than do larger LDL-Cholesterol particles. The relationship of circulating oxidized LDL-Cholesterol to the metabolic syndrome was evaluated in the Health, Aging, and Body Composition Study of 3033 elderly of 70 to 79 years of age to determine CHD risk.

Logistic regression analysis showed that people with the MetS had double the odds (1.82; $p < 0.001$) of having high oxidized LDL-Cholesterol(>1.90 mg/dL) compared with those not having the metabolic syndrome after modification was made for sex, age, ethnicity, and smoking status.

After further adjusting for LDL-Cholesterol, the odds ratio (OR) was even higher, rising to 2.01 ($p < 0.001$). When oxidized LDL-C was exhibit as the percentage of LDL-Cholesterol, the adjusted OR for high oxidized LDL-C (>1.58%) reached to 2.56 ($p < 0.001$). Although LDL-Cholesterol did not independently predict CAD risk, those with high oxidized LDL-C had a greater chance of MI [MI; relative risk, 2.25; 95% confidence interval (CI), 1.22 to 4.15].

Thus, the MetS were shown to be strongly related to higher levels of circulating oxidized LDL-C and an increased risk of CHD. Elevated CRP levels connected to insulin resistance and the presence of metabolic syndrome, especially in women.

Ridkeret al.[21] reviewed the evidence for CRP as a biomarker for CVD risk. They found that 20 prospective epidemiological studies manifest that CRP(C-reactive protein) independently predicted CVD risk, 6 cohort studies confirmed that CRP(c- reactive protein) adds prognostic information beyond that conferred by the Framingham Risk Score, and 8 cohort studies manifested the additive prognostic value of CRP at all levels of the MetS or in the prediction of type 2 diabetes.[21]

Adiponectin is an adipose-derived plasma protein with anti-inflammatory, antiatherogenic, and insulin-sensitizing activity.

So plasma adiponectin concentrations inversely relate with waist circumference, visceral fat, serum triglycerides, fasting plasma glucose, and insulin, and systolic and diastolic hypertension.

Obesity, associated with low levels of plasma adiponectin; consequently, when individuals lose weight, their adiponectin levels rise.

In summary, evidence recommends that assaying biomarkers of non-classic CVD risk–oxidized LDL-C, CRP, and adiponectin–may provide a reliable and cost-effective approach to recognition of patients with the metabolic syndrome.

Metabolic syndrome

Based on the ATP III criteria, metabolic syndrome was classified. 20.6% had 3 components, 28.4% had 4 components, majority i.e. 51% had 5 components identified.

Serum ferritin levels and Metabolic syndrome

In the present study, the mean serum ferritin levels were 126.89 ± 51.77. There was a statistically significant association observed between components of metabolic syndrome and serum ferritin levels as the p-value calculated to be <0.05.

	Serum ferritin levels
Present study	126.89 ± 51.77
Preeti et al,[19]	124.21 ± 52.08
Ramesh et al,[16]	264.2 ± 40.60
Gaurav sharma et al,[22]	124.21 ± 52.08
Sudhakar et al,[12]	187.52
Sivasankari et al,[18]	106.99 ± 28.39

Although iron plays an essential role in many physiological processes, iron excess can lead to tissue damage mediated by reactive free radicals generated through Fenton reaction. The harmful effect of iron lessened through binding to proteins, such as ferritin, which is involved in the homeostasis of iron and acts as an iron storage protein.

Serum ferritin concentration is directly correlated to iron levels in the organism, so the evaluation of levels of this protein in serum used as a primary diagnosis indicator in iron overload-related diseases. However, ferritin levels can also be changed in inflammation, in chronic renal insufficiency, and by metabolic disorders. For this reason, transferrin saturation is used routinely as a complement in the iron overload diagnosis.[23]

During the last years, growing evidence has associated metabolic syndrome with hyperferritinemia. Nevertheless, the relationship between levels of serum ferritin and iron overload is still controversial, while some studies indicate a causative relation of the effects of iron overload in several metabolic syndrome complications.

Some studies specify normal levels of iron and conserved iron regulatory feedback in metabolic syndrome. The origins of high serum ferritin levels associated with metabolic syndrome are not understood as well as the effects involved with this condition.

In our study, the mean serum ferritin levels were 126.89 ± 51.77. there was a statistically significant association observed between components of metabolic syndrome and serum ferritin levels as the p-value calculated to be <0.05 and a significant correlation was observed between serum ferritin and waist circumference (r=0.33, value <0.05), Total Cholesterol (r=0.310 p-value <0.0001), and LDL (r=0.326; p-value <0.0001).

Serum ferritin is an acute-phase reactant, and elevated levels may see in the presence of inflammation. The present study was done to know the association of serum ferritin in metabolic syndrome and also to determine the level of ferritin with components of metabolic syndrome though there is apparent evidence that moderately raised the level of iron storage, which are commonly found genetic hemochromatosis and may cause adverse health outcome.

Patients meticulously examined with a detailed history and laboratory examination. The laboratory investigations included fasting lipid profile, fasting blood glucose, postprandial blood glucose, complete blood picture, and serum ferritin.

In our study, the mean serum ferritin levels were 126.89 ± 51.77. there was a statistically significant association observed between components of metabolic syndrome and serum ferritin levels as the p-value calculated to be <0.05 and a significant correlation was observed

between serum ferritin and waist circumference (r=0.33, p-value <0.05), Total Cholesterol (r=0.310 p-value <0.0001), and LDL (r=0.326; p-value <0.0001).

Iron is a transition metal, tends to catalyze lipid peroxidation leading to the formation of oxidant species and free radicals, which induce tissue injury. Several researchers have postulated the role of oxidative stress and insulin resistance in the etiology of metabolic syndrome. Hence, the high content of iron load may induce disorders of glucose metabolism. Under oxidative stress, an elevated level of serum ferritin may contribute to cellular damage leading to insulin dysfunctions.

Our study also include relation of serum ferritin with each component of metabolic syndrome that is TG, low HDL, central obesity, BP, and fasting blood glucose. a significant correlation was observed between serum ferritin and abdominal circumference (r=0.33, p-value <0.05), Total Cholesterol (r=0.310 p-value <0.0001), and LDL (r=0.326; p-value <0.0001).

Our study also include relation of serum ferritin with each component of metabolic syndrome that is TG, low HDL, central obesity, BP, and fasting blood glucose. a significant correlation was observed between serum ferritin levels and abdominal circumference (r=0.33, p-value <0.05), Total Cholesterol (r=0.310 p-value <0.0001), and LDL (r=0.326; p-value <0.0001).

The relationship between serum ferritin levelsand the MetS examined as a meta- analysis. The study demonstrated that participants with metabolic syndrome had higher serum ferritin levels than the participants without metabolic syndrome.

As we all know that serum iron played a virtually essential role in the process of the body's metabolism, including the section of generating adenosine triphosphate (ATP) in the oxidative respiratory of the chondriosome. It harmed the activity of the various enzymes.

Based on pathologies like type 2 diabetes mellitus, neoplasm, and degenerative brain disorders, this effect would be enhanced. Although the previous studies had proved that the high iron levels are associated with the pathological statue, the actual data is ambiguous for us.

On account of regional differences, gender gap, and the distinction between premenstrual and menstrual for the same woman, perhaps they are the real reasons why the heterogeneity of statistical analysis is so evident.[24]

The World Health Organization (WHO) has provided the data in the aspect of storing and regulating iron (>200 ng/L for men and >150 ng /L for Women). However, the value of ferritin was lower than the given value in the WHO; the serum ferritin levels in the menstrual were lower than in ante menstruation. In other words, the latter has a higher probability of developing metabolic syndrome.

Our meta-analysis suggests that the men or pre-menopausal women whose serum ferritin levels are lower than the WHO cut-offs for iron overload could suffer from metabolic syndrome easily. In the early stages, high serum ferritin levels could be an indicator by health examination to detect the risk of developing metabolic syndrome.[24]

CONCLUSION

- There is a positive association between elevated iron stores, measured by serum ferritin levels, and the prevalence of the metabolic syndrome.
- Serum ferritin levels correlated with increasing number of components of the metabolic syndrome.

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