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Original Research Article

STUDY OF CORRELATION OF SERUM FERRITIN AND CRP LEVEL IN A CASE OF METABOLIC SYNDROME Z

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Abstract

Background: Sleep disturbances have been associated with individual components of the metabolic syndrome ("syndrome X") and although the concept has been proposed, it is not known whether sleep disturbances actually cluster with features of the metabolic syndrome to produce a unifying trait, "syndrome Z". Sleep disturbances have been associated with individual components of the metabolic syndrome ("syndrome X"). Obstructive sleep Apnea (OSA) has been linked to all four of the more well-established metabolic syndrome components, raising the possibility of a "syndrome Z.". Inflammation contributes to metabolic syndrome (MetS) symptoms. Clinical indications are known to emerge in the great majority of patients, including cardiovascular disease, type 2 diabetes, and obstructive sleep apnea (OSA). **Materials and Methods:** Nonspecific acute phase reactant C-reactive protein (CRP) levels are increased with infection or inflammation. C-reactive protein, an inflammatory biomarker is the most thoroughly defined and established indicator of inflammation (CRP). Another acute phase reactant, ferritin, has been linked to insulin resistance, multiple sclerosis (MS), diabetes, and MetS. Ferritin controls the homeostasis of iron and is used as a biomarker to measure the body's iron reserves. In this study, we measured CRP and Ferritin values of patients with metabolic syndrome Z. **Results:** The minimum and maximum range of CRP values in the sample study calculated was 3 mg/L and as high as 112 mg/L, respectively. The mean SD value of female and male ferritin levels was also calculated individually which were 297.76 ± 107.3 and 388.78 ± 386.9. Our study represents that the highest number of patients (84%) with the range of 100 – 500 mg/L of ferritin value. There was no significant difference between CRP and ferritin levels in males and females with the p-value of 0.0014 and 0.005, respectively. **Conclusion:** Consequently, the test's p-value was statistically significant, suggesting that CRP and ferritin might be used for the identification of patients with MetS Z.

INTRODUCTION

In 1977, Haller coined the term "metabolic syndrome" (MetS) to refer to the combination of hypertension, dyslipidemia, obesity, and abnormal glucose metabolism. He showed how the combination of several of these factors raised the risk of cardiovascular disease.[1] Type 2 diabetes (T2D) and cardiovascular disease (CVD) are more likely to develop in people with the metabolic syndrome, which is the co-occurrence or clustering of metabolic abnormalities.[2] The prevalence of the metabolic syndrome is rising everywhere globally.[3-5] In addition to hyperinsulinemia and glucose intolerance, these abnormalities also included elevated levels of triglycerides, glucose, cholesterol, and insulin.[6] The principal regulator of blood glucose levels is glucose metabolism, which is regulated by glucose uptake in adipocyte and muscle cells and inhibits glucose synthesis in the liver. Insulin resistance (IR) is the term for the inability of insulin to facilitate normal glucose uptake by fat and muscle and to suppress hepatic glucose synthesis.[7] One important pathogenic aspect of obesity and type 2 diabetes is chronic elevated threshold of insulin resistance (IR).[8] Common clinical and physiological characteristics of MetS include IR.[9] Gerald Reaven proposed the "Syndrome X" hypothesis in the late 1980s, sometimes known as Metabolic X-syndrome or MetS, which holds that insulin resistance may be the common denominator connecting numerous constellations of disorders.

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These abnormalities included hyperinsulinemia, glucose intolerance, and increased triglycerides, glucose, cholesterol, and insulin levels.[10]

Obstructive sleep apnea (OSA), sleep deprivation, and sleep fragmentation are among the sleep disorders that have recently been linked to the development of the metabolic syndrome.[11] Up to 17% of middle-aged adults may suffer from OSA, a chronic condition marked by recurrent episodes of partial or complete cessation of breathing while sleeping.[12] OSA has also been linked to all four of the more well-established components of the metabolic syndrome.[11], raising the possibility of a "syndrome Z.".[13] Additionally, experimental and epidemiologic investigations have linked sleep deprivation and fragmentation to the aetiology of hypertension.[14] and poor glucose tolerance.[15-19] Recent research has shown that suppressing deep or slow wave sleep (SWS), without affecting the amount of time spent sleeping overall, decreases insulin sensitivity and glucose tolerance.[20]

One of the essential proteins that controls iron homeostasis is ferritin, which is also an extensively used clinical indicator of iron status. According to several researches, rising serum ferritin (SF) levels are substantially associated with an increase in the prevalence of atherosclerosis and IR. SF has been found to be a reliable instrument for measuring body iron stores since it removes the confounding effects of inflammatory, hepatic, or neoplastic illnesses.[21] Increased ferritin levels were independently and favorably related to having MetS, with an odds ratio greater than 1.73, according to a recent meta-analysis.[22] The elevated SF levels, according to Liu et al., enhanced the likelihood of cardiovascular risk factors and the emergence of insulin resistance in first-degree relatives with a history of diabetes.

A highly sensitive indicator of systemic inflammation is C-reactive protein, an acute-phase reactant made by the liver.[23] Most CVD are caused by atherosclerosis, an inflammatory process that begins early in life and advances slowly and silently for decades.[24] CRP (C-reactive protein), one of several inflammatory indicators produced in the liver in response to interleukin-6 (IL-6), has emerged as the most potent inflammatory marker of future cardiovascular risk and has received the greatest attention, particularly in clinical trials.[25] Although the precise mechanisms are still unclear, it is believed that T2D may have its roots in chronic low-grade inflammation, which is demonstrated by raised high-sensitivity C-reactive protein (CRP). High sensitivity CRP has also become a potent indicator of CVD in addition.[26]

The International Diabetes Federation (IDF), revised National Cholesterol Education Program (NCEP-R), NCEP Adult Treatment Panel (ATP)-III, and American Association of Clinical Endocrinologists (AACE) were evaluated for specificity and sensitivity using the World Health Organization's (WHO) guidelines as a guide to determine the best criteria for diagnosis.[27]

Nowhere is the epidemic more severe than in India, where 32 million individuals were estimated to have metabolic syndrome by the year 2020, according to World Health Organization (WHO) studies. An ideal biomarker should enhance the ability to identify people who are at increased risk for the development or progression of a disease, enhance the ability to anticipate illness consequences, and/or direct and assist in customizing responses to various therapies. Additionally of relevance are biomarkers that provide information on illness pathophysiology. In context of this, this study describes a biomarker associated with the metabolic syndrome with a particular emphasis on serum ferritin levels and their relationship to the condition. Since there aren't many studies from India, it's crucial to conduct a research. Thus, this study examines if early prediction provided by the previous research can stop the progression of metabolic syndrome Z and stop or reduce consequences.

MATERIALS AND METHODS

Data sources and study population

The study protocol was approved by the Institutional Ethical Committee of Darbhanga Medical College and Hospital. Approximately one hundred participants in the age group of 25 to 59 years belonging to both the sexes were included in the study. All the study participants were from Darbhanga. The study was carried out in the Department of Internal Medicine, Darbhanga Medical College and Hospital during the period of July 2021-December 2022 with both inpatient and out patient. The study was done with the help of Department of Biochemistry, pathology and microbiology for various biochemical parameters.

The patients were selected on the basis of inclusion and exclusion criteria Hospital based (Single centre) Cross sectional study. In all those patients, metabolic syndrome Z was diagnosed. The study included both sexes. Numbers of patients were included in the study group after applying exclusion criteria. The sample population was predominantly obtained from the patients attending the diabetic clinic and medicine outpatient department of our hospital.

This is a cross sectional population-based study. The study population was selected randomly among the out patients. Out of the many definitions applied worldwide for metabolic syndrome, the ATP III guidelines are the only which has been approved and accepted by many quarters. It is the one which has been extensively used in the clinical trials of metabolic syndrome too. Hence, we applied the NCEP/ATP guidelines (with current modification) for selecting the study group.

Data Collection

A detailed Performa was filled up for each patient which included age, sex, dietary habits, smoking, alcoholism, conditions associated with high ferritin

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and CRP levels like Hereditary Hemochromatosis, alcohol intake, Viral Hepatitis and Inflammatory conditions. The age of onset and duration of diabetes was recorded. The patient's diabetes diagnosis method—FPG, plasma glucose criteria, or HBA1C—was also noted.

Inclusion Criteria

The patient should fit into the definition of metabolic syndrome Z as given below:

1. Diagnosed diabetes by FPG and/or 2 hours plasma glucose criteria or HBA1C > 6.5%
2. No data missing for body mass index (BMI), waist circumference (WC), blood pressure measurements, FPG, 2 Hour's plasma glucose.

Exclusion Criteria

Conditions associated with high ferritin and CRP levels like

1. Hereditary Hemochromatosis
2. Patients on regular alcohol intake
3. Viral Hepatitis like A, B, C
4. Inflammatory conditions like SLE, rheumatoid arthritis chronic anaemia.

Physical Examination

The patients underwent routine physical examination and anthropometric measurements for waist circumference and weight & height calculation:

In patients wearing very loose clothing, without any footwear and measured weight was rounded off to multiples of 100 grams.

Measurement of height was done by using WHO proposed protocol with making the patients stand without any footwear. This method is the commonly followed one all over the world.

Body mass index (BMI) was calculated by body weight in kilogram divided by square of height in meters.

Waist circumference was measured at midpoint between lower costal margin and highest point of iliac bone in mainly around the widened region of gluteus using a measurement tape which is circled over the abdomen without any wrinkles and stretching. While measuring there should not be any pressure on the surface of body. Values are rounded off to nearest 1 mm. Quality of the tape is to be in such way that it should not be too elastic and too rigid.

Blood investigations

VITAL SIGNS - Pulse rate, Respiratory rate -Blood pressure in mm of Hg was measured using Mercury Sphygmomanometer in sitting posture. Hemoglobin (grams %) was estimated by Cyanmethemoglobin method. Fasting and Postprandial blood glucose (mg/dl) were estimated by GOD-POD method in Auto quant 100/200 analyzer. Hba1c % (Glycated Hemoglobin) was measured by Latex Enhanced Immunonephelometric assay using Nepheloquant Specific Protein Analyzer. Fasting serum lipid profile (mg/dl) was analyzed in Auto quant 100/200 Automated Clinical Chemistry Analyzer. (Cholesterol by Trinder's method, Triglycerides by GPO Trinder's method, HDL and LDL by direct enzymatic colorimetric method, VLDL by calculation). Serum Ferritin (ng/ml) was estimated by Particle Enhanced Turbidimetric Immunoassay in COBAS MIRA PLUS chemistry analyzer. CRP levels were measured by latex-enhanced nephelometry (Fully Automated Nephelometry BN 100).

Normal values

Parameter Unit Normal Range

- Hemoglobin 12.0 to 17 gm%
- Total count-4500 to 11000 cells /microliter
  Differential count:
- Neutrophils-55 to70%
- Lymphocytes-20 to40 %
- Monocytes-2to 8 %
- Eosinophils-1to 4 %
- Basophils-0.5 to 1 %

Esr

- Males - 0 to 22mm/hr
- Females - 0 to 29 mm/hr
- Fasting Plasma Glucose 70 to 110 mg/dl
- Postprandial Glucose 90 to 140 mg/dl
- Hba1c %:
- to 6.0 % Normal
- 6.0 to 7.0 %control
- >7.6% poor control
  Serum Ferritin:
- 30 to 300 ng/ml for men
- 10 to 160 ng/ml premenopausal women
- 30 to 300 ng/ml postmenopausal women

Serum creatinine

- For adult men, 0.74 to 1.35 mg/dl (65.4 to 119.3 micromoles/L)
- For adult women, 0.59 to 1.04 mg/dl (52.2 to 91.9 micromoles/L)
- Creatinine levels in blood (Blood urea 6 to 24 mg/dl (2.1 to 8.5 mmol/L)

CRP titer

- Normal: Less than 10 mg/L
- High: Equal to or greater than 10 mg/L
- Gamma-glutamyl transferase (GGT) 5 to 40 U/L (units per liter)
- Total Cholesterol mg/dl <200
- Triglycerides mg/dl 35 to 170
- HDL Cholesterol mg/dl 35 to 55
- LDL Cholesterol mg/dl <100
- VLDL mg/dl 25 to 50

Polysomnography

We objectively measured sleep parameters using overnight 14-channel polysomnography (PSG) obtained in a clinical research unit Polysomnography refers to a systematic process used to collect physiologic parameters during sleep. PSG is considered to be the gold standard for diagnosing sleep-related breathing disorders, which include obstructive sleep apnea (OSA). An apnea was defined as a complete or almost complete cessation of airflow, as measured by a nasal-oral thermocouple, lasting 10 seconds or longer. The

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patients underwent overnight polysomnography which included multichannel electroencephalographic (EEG), Electromyographic (EMG) and electrooculographic (EOG) recording and respiratory monitoring using nasal thermistor.

- Electroencephalographic (EEG): An EEG can find changes in brain activity that might be useful in diagnosing brain disorders such as sleep disorders
- Electromyography (EMG) is a diagnostic procedure to assess the health of muscles and the nerve cells that control them (motor neurons). EMG results can reveal nerve dysfunction, muscle dysfunction or problems with nerve-to-muscle signal transmission.
- Electrooculogram (EOG) records eye movement because of a voltage difference between the cornea and the retina
- Respiratory monitoring using nasal thermistor: Thermal airflow sensors use the difference between the temperature of exhaled and ambient air to estimate airflow and detect mouth breathing. The use of temperature as a surrogate for measurement of airflow works well for detecting apnea because it has the advantage to detect both nasal and oral airflow. Oronasal sensor from Somnomedics, effective range = ± 80 mv, frequency range = 0.1 Hz to 1 kHz, sampling rate = 32 Hz and software low-pass (LP) filtering at 1 Hz.

Statistical Method

Data analysis in this Case-Control Study was done by using IBM SPSS (Statistical Package for Social Sciences) software version 16.0 for windows 10.0. Statistical analysis using independent t-test was done to find out the significance of difference. One way Analysis of Variance (ANOVA) was applied to compare means within and between the three groups. Pearson's correlation Coefficient was applied to find out statistical correlation between two variables and its significance. The confidence interval was set at 95% and p-value< 0.05 was considered significant.

RESULTS

Descriptive Characteristics

The study sample included fifty patients, male and female. The age of the study sample ranged from 18 years to 85 yrs. Mean SD value for age was 54.16 ± 14.67. Among of all subjects, 66% patients were male while 34% patients were female for comparative analysis of CRP and Ferritin level. All subjects were analyzed for two parameters: CRP level ranging from 3 mg/L to 115 mg/L and Ferritin level ranging from 100 mg/L to 2400 mg/L.

Age

The age of the study sample among 50 patients ranged from minimum 18 years to maximum 85 years of age with the mean SD age of 54.16 ± 14.67 (Table 1). Highest number of patients belonged to age group of 41 – 60 years with total number of 23 (46%) patients among 50 patients, followed by the age group of 61 – 80 years with 17 (34%) of patients. In this study, there were only 2% of patients in the age group of above 80 years. However, 7 patients comprising of 14% of total patients were in the age group of 21 – 40 years, while 2 patients were below the age group of 20 years comprising 4% of the total study population (Table 1).

Gender

In this study, out of 50 patients of metabolic syndrome Z, 33 patients comprising of 66% of total population were male, whereas 17 (34%) were female. Thus, the majority of the total populations suffering from metabolic syndrome Z were male compared to female population (Fig. 1).

CRP Level

In this study, C-reactive protein level was measured in the total population of 50 patients suffering from metabolic syndrome Z. The mean SD value of the total population measured was 25.8 ± 26.37 with standard deviation error of 3.72. The minimum and maximum range of CRP value in the sample study calculated was 3 mg/L and 112 mg/L respectively (Table 2). The mean SD values of male and female CRP levels were also calculated individually which were 30.15 ± 28.92 and 17.36 ± 18.46 (Table 2).

Different range of CRP value was calculated and differentiated into different ranges for both male and female patients suffering from metabolic syndrome Z (Table 3). Number of patients having measured CRP value of 3 – 10 mg/L were 14 (28%), in which 16 (8%) were male and 12% (6) were female. The highest number of patients were measured to have CRP range value from 11 – 30 mg/L with 54% (27) of total population, comprising of 17 (34%) of male and 10 (20%) of female patients. However, there were no female patients in the range 31 – 50 mg/L, 51 – 70 mg/L and 91 – 120 mg/L of CRP value and only 1 female observed in the range of 71 – 90 mg/L. On the other hand, 1 patient was observed in each CRP range of 31 – 50 mg/L and 91 – 20 mg/L. There were 2 (4%) and 4 (8%) male patients in the CRP range of 51 – 70 mg/L and 71 – 90 mg/L (Fig. 2).

Ferritin level

In this study, ferritin levels were measured in the total population of 50 patients suffering from metabolic syndrome Z. The mean SD value of the total population measured was 357.84 ± 321.6 with standard deviation error of 45.4. The minimum and maximum range of ferritin value in the sample study calculated was 100 mg/L and 2400 mg/L respectively (Table 4). The mean SD value of female and male Ferritin levels was also calculated individually which were 297.76 ± 107.3 and 388.78 ± 386.9.

Different range of ferritin value was calculated and differentiated into different ranges for both male and female patients suffering from metabolic syndrome Z (Table 5). The highest number of patients having

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measured ferritin value of 100-500 mg/l was 42 (84%), in which 50% (25) were male and 34% (17) were female. However, there were no male and female patients in the range 1001-1500 mg/l and 1501-2000 mg/l of ferritin value and only 1 female observed in the range of >2000 mg/l. On the other hand, 7 patients were observed in ferritin range of 501-1000 mg/l (Fig. 3).

Statistical Analysis

The data are reported as the mean +/- SD or the median, depending on their distribution. A p value of <0.05 using was taken as being of significance for all statistical tests. All data were analyzed with a single factor Anova test for all the groups by showing statistics of each group in sum, average and variance data using SPSS software and Microsoft Excel. It was observed that statistically there was no significant difference and comparison between male and female's CRP and ferritin value with significant improvement. There was no significant difference between CRP and ferritin levels in male and female with the p value of 0.0014 and 0.005 respectively. Hence the test was statistically significant as p value denoted in the Table 6 and 7.

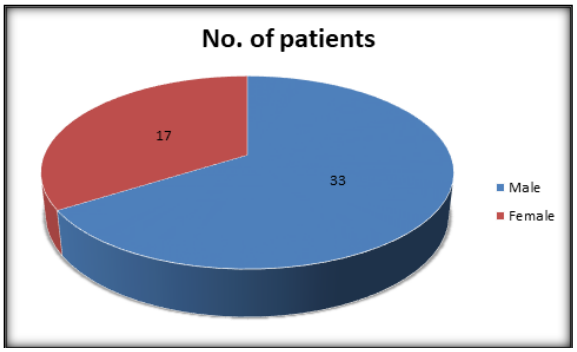

Figure 1: Chart representing distribution of male and female patients

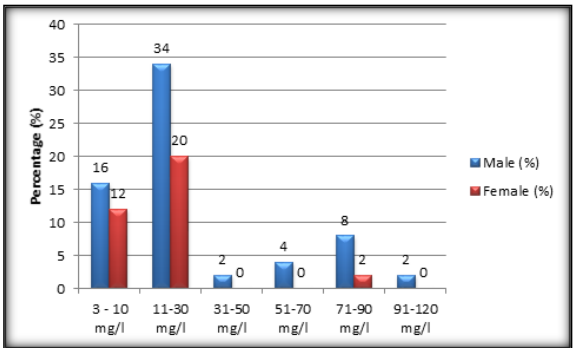

Figure 2: Graphical representation ferritin value range of male and female

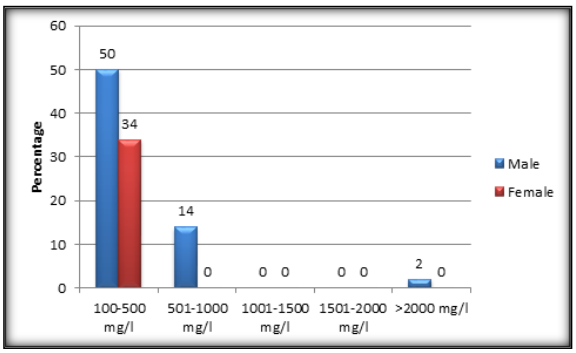

Figure 3: Graphical representation ferritin value range of male and female

Table 1: Distribution of patients according to age group

Age in years	No. of patients	Percent (%)
<20	2	4
21-40	7	14
41-60	23	46
61-80	17	34
>80	1	2
Total	50	100
Mean	54.16	--
Standard Deviation	14.67798574	--
Standard Deviation error	2.07578065	--

Table 2: Mean demographic data of CRP value in total population

CRP	Mean	Standard Deviation	Standard Deviation ERROR	Min range	Max range	No. of patients
	25.8	26.37022367	3.729312795	3	112	50
Female	17.36	18.46949377	4.479510215	5	85	17
Male	30.15	28.92892282	5.035879075	3	112	33

Table 3: Range of CRP value in total population of metabolic syndrome Z patients

	Male		Female		Total	
CRP	No.	Percentage	No.	Percentage	No.	Percentage
3 - 10 mg/l	8	16	6	12	14	28
11-30 mg/l	17	34	10	20	27	54

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31-50 mg/l	1	2	nil	0	1	2
51-70 mg/l	2	4	nil	0	2	4
71-90 mg/l	4	8	1	2	5	10
91-120 mg/l	1	2	nil	0	1	2
	33	66	17	34	50	100

Table 4: Mean demographic data of ferritin value in total population

Ferritin	Mean	Standard Deviation	Standard Deviation Error	Min range	Max range	No. of patients
	357.84	321.6338	45.48589	100	2400	50
Female	297.76	107.331	26.03159	112	480	17
Male	388.78	386.9628	67.36158	100	2400	33

Table 5: Range of ferritin value in total population of metabolic syndrome Z patients

Ferritin	Male		Female		Total	
	No.	Percentage	No.	Percentage	No.	Percentage
100-500 mg/l	25	50	17	34	42	84
501-1000 mg/l	7	14	0	0	7	14
1001-1500 mg/l	0	0	0	0	0	0
1501-2000 mg/l	0	0	0	0	0	0
>2000 mg/l	1	2	0	0	1	2
	33	66	17	34	50	100

Table 6: Statistical significance of CRP and ferritin in male and female

	Variance		P-value
	CRP	Ferritin	
Female	341	11519	0.005
Male	836	149740	0.0014

Table 7: Statistical correlation of CRP and Ferritin value in total population using Anova: Single Factor

SUMMARY						
Groups	Count	Sum	Average	Variance		
CRP	50	1290.12	25.8024	695.3887		
Ferritin	50	17892	357.84	103448.3		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2756224	1	2756224	52.93118	0.0008	3.938111
Within Groups	5103041	98	52071.84			
Total	7859265	99				

DISCUSSION

The results of this clinical-based study showed that metabolic syndrome (MetS) and the obstructive sleep apnea syndrome (OSAS) are closely related. The association was stronger in men than in women. Despite the fact that not every individual met the requirements for MetS. MetS components were risk factors for OSAS, and the risk increased with the number of components. In this study, we have measured CRP and Ferritin values of patients having metabolic syndrome Z.

C-reactive protein

Inflammation contributes to MetS symptoms such as obesity, insulin resistance, and others. This has been supported by studies of a link between insulin resistance or MetS components and high levels of C-reactive protein (CRP), a sensitive marker of subclinical inflammation.[28-31], Diabetes is also predicted by high CRP levels.[32,33] One of the indicators of subclinical inflammation, high levels of high-sensitivity C-reactive protein (hs-CRP), have been linked to the metabolic syndrome and an elevated risk of T2DM and CHD.[34]

In our study, C-reactive protein level was measured in the total population of 50 patients suffering from metabolic syndrome Z. The mean SD value of the total population measured was 25.8 ± 26.37 with standard deviation error of 3.72. The minimum and maximum range of CRP value in the sample study calculated was 3 mg/L and high as 112 mg/L respectively. It's significant to note that South Asians have been found to have greater levels of hs-CRP than white Caucasians.[35] In comparison to European women, South Asian women had CRP levels that were twice as high, which were linked to dyslipidemia, abdominal obesity, and higher fasting/2-hour insulin levels. Additionally, when compared to Caucasians, South Asians had a 14% higher risk of CHD when their hs-CRP levels were high.[36] CRP levels in healthy individuals range from 0.9 mg/L to 2.05 mg/L and never rise above 5 mg/L. When there is bacterial infection and cell necrosis, the CRP level rises above 40 mg/L.[37]

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The relationship between MetS and OSA is well supported by the available data. It is evident that OSA alone causes insulin resistance, a MetS component.[38] These patients appear to have reduced insulin sensitivity and increased fasting insulin levels.[39] These patients have elevated levels of adrenaline, norepinephrine, and/or cortisol, which increases gluconeogenesis and decreases glucose absorption by skeletal muscle.[40]

According to MADRIC study, metabolic syndrome and all its individual components were associated with high CRP levels, with the strongest association being found for high waist circumference (P <0.001). Clinical research article published in Circulation 2004.[41] and supported by American Heart Association concludes that CRP was strongly related to all anthropometric and direct measures of total and central abdominal obesity. In another study, the percentage of participants with a concentration of CRP >3.0 mg/l was 38.4% among those with the metabolic syndrome and 10.3% among those without the syndrome (P = 0.007) in which among the 1,366 participants, CRP concentrations ranged from 0.1 to 65.2 mg/l (geometric mean 0.5 mg/l, median 0.4 mg/l).[42]

Thirty-five patients had CRP > 3mg/dL, and there were no statistical differences in comparison between genders (female 3.11mg/dL x male 2.74mg/dL, respectively, Z = 0.54; P = 0.59).[43] The mean SD value of male and female CRP levels were also calculated individually which were 30.15 ± 28.92 and 17.36 ± 18.[46]

Similarly, the median value of CRP (with interquartile range) of men and women in this study was very similar; 1.4 mg/1 (0.7, 2.4) for men and 1.4 mg/1 (0.6, 2.3) for women. Interestingly, comparison by sex has rarely been presented by other studies.[44]

Serum Ferritin

The temporal link between MetS and elevated ferritin levels,[45,46] appears to clearly predate the onset of diabetes.[47] Increased ferritin, on the other hand, appears to represent both the participation of inflammation, like CRP does, and the independent activities of extra iron. A marker of inflammation like S-Ferritin would be expected to be higher in persons with OSA given that many OSA patients are obese, have CVD, hypertension, and systemic inflammation. There is, however, limited evidence that OSA affects S-Ferritin levels independently of obesity. In order to determine if OSA could worsen the symptoms of daytime sleepiness and irregular limb movements by promoting lower body iron storage, O'Brien et al [48] measured the levels of S-Ferritin in 80 suspected OSA patients. Results, in contrast to their prediction, showed that lower minimum oxygen saturation (worse OSA), but not AHI, predicted greater S-Ferritin levels, maybe indicating the inflammatory process in OSA.

In our study, out of total 50 populations the mean SD value of the total population measured was 357.84 ± 321.6 with standard deviation error of 45.4. The minimum and maximum range of Ferritin value in the sample study calculated was 100 mg/L and 2400 mg/L respectively. The mean SD value of female and male Ferritin levels was also calculated individually which were 297.76 ± 107.3 and 388.78 ± 386.9. Our study represents that the maximum ferritin value 2400 mg/L was observed and measured in male patients compared to female patients (480 mg/L) out of total population.

In one study, unadjusted analyses revealed that OSA males had significantly greater levels of S Ferritin than controls (213.3 vs. 197.3 g/L, p = 0.007). S-Ferritin levels in females showed a similar pattern to that in males, although the results were not statistically significant (p = 0.115). Higher S-Ferritin levels were found to significantly correlate with OSA in a study by O'Brien et al. among 80 OSA patients.[48] Elevated blood ferritin was substantially related with elevated triglycerides and glucose levels, according to a comprehensive review and meta-analysis of 26 studies conducted by Suarez-Ortegon et al 2018.[49] Additionally, they discovered that the relationship between ferritin and MetS may be influenced by hepatic damage, BMI, and the kind of ferritin assay. Evidence suggests that the metabolism of iron and glucose is influenced in both directions.[50,51] Additionally, it has been discovered that elevated ferritin levels are linked to other MetS features such as hypertension, dyslipidemia, elevated fasting insulin and blood glucose levels, and central adiposity.[52-54]

Our study represents that the highest number of patients (84%) were having the range of 100 – 500 mg/L of ferritin value while the lowest number of patients were 2% having the ferritin value of higher than 2000 mg/L.

Statistical Analysis

Results from the Multiple Risk Factors Interventional Trail (MRFIT) showed that CRP and coronary heart disease mortality in men were directly positively correlated (RR 14 2.8; 95% CI, 1.4-5.4).[55] In one study, unadjusted analyses revealed that OSA males had significantly greater levels of S Ferritin than controls (213.3 vs. 197.3 g/L, p = 0.007). S-Ferritin levels in females showed a similar pattern to that in males, although the results were not statistically significant (p = 0.115).[56]

In our study, p value of <0.05 using was taken as being of significance for all statistical tests. It was observed that statistically there was no significant difference and comparison between male and female's CRP and ferritin value with significant improvement. There was significant difference between CRP and ferritin levels in male and female with the p value of 0.0014 and 0.005 respectively. Hence the test was statistically significant as p value.

Study by Earl et al, 2005[42] showed that the prevalence of the metabolic syndrome was 5.2% (6.3% among males and 4.1% among females, P = 0.233). In comparison, 10.3% of adolescents

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without the syndrome had such a concentration of CRP (P = 0.007). In another study of a subsample (n=72), the CRP average was slightly higher among individuals under topical treatments compared to those using systemic therapies, but with no statistical significance (3.15 mg/dL vs 2.70 mg/dL; P > 0.05); also, absolute 10-year CVR (9.2% vs 9.5%) and MetS frequencies (31.0% vs. 25.6%; P=0.61), respectively, were similar in these groups 43.

CONCLUSION

Our study suggests that CRP and ferritin might be used for identification of patients with MetS Z; however, it is essential to evaluate the role of CRP and ferritin with a biomarker. The main limitation is the different criteria that are nowadays used for defining MetS Z. OSAS is considered a major cause of MetS, and MetS can likewise trigger the development of OSAS. In this nationwide population-based analysis adjusted for several confounding factors, we confirmed the association of MetS components with OSAS. This is important because the coexistence of two pathologies within the same patient increases the levels of biomarkers, which directly contribute to, or increase the potential for, complications.

It is concluded that in our study among of all 50 subjects to investigate the association of serum ferritin and CRP in a case of metabolic syndrome Z There were no significant difference between CRP and ferritin levels in male and female with the p value of 0.0014 and 0.005 respectively. Hence the test was statistically significant as p value. Hence, the prevalence of metabolic syndrome (MetS) is increasing with the aging of the population and the prevalence of obesity. More information is needed on the factors affecting the progression of MetS Z and its level of CRP and ferritin on the markers that could help recognize the subjects at high risk in clinical work.

Authors Contribution

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Declaration of Conflicting Interests

The Authors declare that there is no conflict of interest.

Abbreviation: MetS = Metabolic Syndrome, MetS Z = Metabolic Syndrome Z, CRP = C-reactive protein, OSA = obstructive sleep apnea, IR = insulin resistance, SF = serum ferritin, IDF = International Diabetes Federation, NCEP-R = revised National Cholesterol Education Program, ATP-III = NCEP Adult Treatment Panel, AACE = American Association of Clinical Endocrinologists, WHO = World Health Organization's.

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