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Thyroid Dysfunction in Patients with Metabolic Syndrome in Sudan

Khanssa Osman[a]*, Dalia Ibrahim[b]

[a]*Mashreq University, Faculty of Medicine, Khartoum North Sudan*
[b]*Mashreq University, Faculty of Medical Laboratory Science , Khartoum North Sudan*
[a]*Email: khonsawadosman123@gmail.com* , [b]*Email: Daliawigealla@yahoo.com*

Abstract

Metabolic syndrome defined by the presence of hyperglycemia, insulin resistance, obesity, hypertension and dyslipidemias.This study is about thyroid dysfunction in Sudanese patients with metabolic syndrome. The study was conducted in two specialized centers in Khartoum, the first one is Jabir Abu Eliz Specialized Diabetes Centre and Quasbaa specialized Diabetes and Endocrine center, in the period from September to December 2019. The importance of such study is that both condition carry increased cardiovascular risks. The aim of this study is to determine the prevalence of thyroid dysfunction among patients with metabolic syndrome in Sudanese patients. It also aims at evaluation of metabolic syndrome components in relation to thyroid status. The patients with metabolic syndrome were randomly selected during their regular visits to the mentioned centers. The diagnosis of metabolic syndrome (MetS) depended on the IDF worldwide used criteria. Thyroid function tests were done in all patients. Patients' history, clinical exam including BP, WC, BMI, record of FBS, HbA1c, were all recorded. Obtained data were then analyzed using SPSS software Version 16. Thyroid dysfunction (TD) is a prevalent disorder detected in 38% of Sudanese patients with metabolic syndrome (MetS). Female are more frequently affected (68%) by metabolic syndrome and thyroid dysfunction than men. High TSH level is associated with increased BMI in euthyroid patients. TD is common in patients with metabolic syndrome. Females are by far more common to develop metabolic syndrome and thyroid dysfunction. Screening tests in such patients should be considered for early detection and management to ameliorate cardiovascular risks

Keywords: Thyroid; Dysfunction; Metabolic Syndrome; Sudan.

1. Introduction

Jabir Abu Eliz Centre (JADC) was inaugurated in 1998 by the Khartoum state ministry of health as the first multidisciplinary specialized diabetic center in the Sudan. It caters for 400000 registered diabetic patients with a monthly turn-over of 450 new patients and 200 outpatients per day.

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* Corresponding author.

It encompasses six surgical clinics, five medical clinics, one clinic for dermatology, medical orthosis, ophthalmology and podiatry. Moreover, JADC provides services in health educations, social and psychological support. It also provides research opportunities for postgraduate doctors.

Metabolic syndrome is defined as a clustering of hyperglycemia/ insulin resistance, obesity, hypertension, and dyslipidemia which share increased cardiovascular risk and risk of developing type 2 diabetes mellitus (T2DM). All these conditions are interrelated and share underlying mediators, mechanisms and pathways [1] With several definitions for metabolic syndrome, the World Health Organization considers insulin resistance as central to the development of metabolic syndrome. The IDF consensus worldwide definition of the metabolic syndrome (2005) is divided into 2 parts:

1.2 Part 1

worldwide definition for use in clinical practice (Depending on these criteria we diagnose our patient in the current study) .The consensus statement from the International Diabetes Federation (IDF) defines metabolic syndrome as patients having *central obesity* as identified by waist circumference equal to or more than 94cm for the Europid males and equal to or more than 80cm for Europid females with ethnicity specific values for other groups, plus any two of the following criteria:

- Raised Triglyceride (TG) level :> 150 mg/dL(1.7mmol/L), or specific treatment for this lipid abnormality.
- Reduced HDL cholesterol (high density lipoprotein): <40 mg/dL (1.0mmol/L) in males and < 50 mg/dL (1.3 mmol/L) in females
- Raised blood pressure: systolic BP ≥130 or diastolic BP ≥ 85 mm Hg, or previously diagnosed hypertension
- Raised fasting plasma glucose (FPG) ≥ 100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes. If above 5.6 mmol/L or 100 mg/dL, OGTT is strongly recommended but is not necessary to define presence of the syndrome (IDF consensus, 2005).

As the IDF (International Diabetes Fedration) recommended ethnic specific values for the waist circumference, in United States of America the ATP III (Adult Treatment Panel III), and the report of National Cholesterol Education Program (NCEP) values for the waist circumference (102) cm for males; (88) cm for females are used in clinical practice. The consensus advised for the eastern Mediterranean and the Middle East (Arab) populations to use European data until more specific data are available.

1.3Part 2

'Platinum standard' definition—additional metabolic criteria for research. The IDF consensus group has highlighted a number of other parameters that appear to be related to the metabolic syndrome which should be included in research studies to help determine the predictive power of these extra criteria for CVD and/or diabetes. The use of these additional factors will also allow further modification of the definition.

The additional metabolic criteria for research include the following:

- Abnormal body fat distribution.

-Atherogenic dyslipidemia (beyond elevated triglyceride and high-density lipoprotein HDL).

-Dysglycaemia.

-Insulin resistance (other than elevated fasting glucose).

-Vascular dysregulation (beyond elevated blood pressure).

-Pro-inflammatory state.

-Pro- thrombotic state.

-Hormonal factors.

1.3Metabolic Syndrome the Global Malady

The prevalence of metabolic syndrome is different in different parts of the world. The condition became the major health problem of modern world[2]. The incidence of metabolic syndrome parallels the incidence of obesity and incidence of type 2 diabetes. The global survey of obesity which was conducted in 195 countries in 2015, demonstrated that 604 million adults and 108 million children were obese. The highest prevalence of obesity was found in low socio-economic index countries. The study also showed that the prevalence increased from 1.1% in 1980 to 3.85% in 2015.[2] Global mortality related to high BMI has increased by 28.3% between the years 1990 to 2015. Obesity also was found to cause 120 million disability-adjusted life years. Unfortunately the rate is higher in childhood obesity [3].

In Sudan according to a study published in 2017 -authors found that the prevalence of obesity was 21.2% and women have higher prevalence [4]. The results of the study also showed association between central obesity, diabetes and hypertension.

2. Material and Method

2.1 Study design

This is descriptive, analytical, cross-sectional, case control and hospital base study

2.2 Study area

This study carried out in two different centers Jabir Abu Eliz Specialized diabetes Centre and Quasbaa Diabetes and Endocrine centre.

2.3 Study Period

The study was conducted in the period from September to December 2019.

2.4 Study Population

- Patients who participate in the study were chosen from those who attend the referral clinic for their regular follow up.
- The patients who fulfill the diagnosis of metabolic syndrome were identified.
- The diagnosis of MetS was based on IDF criteria.
- The patients were included in the study after obtaining informed consent on participating on the study.
- 110 patients fulfilled the IDF/National Cholesterol Education Program (NCEP) Panel III criteria for metabolic syndrome.

Clinical assessment of the patients includes: measurement of blood pressure (BP). Anthropometric measurements such as weight (Wt), height (Ht) were taken using a standard scale. Stadiometer was used for measurement of waist circumference in centimeter (cm) along the mid-point between the costal margin and the iliac crest. Patients' hospital documents regarding triglyceride (TG), and high density lipoprotein, HbA_1c were reported. Blood samples were drawn to be tested for thyroid hormones. Data was collected using designed, pretested questionnaire.

2.5 Inclusion criteria

This study includes all patients who fulfill 3 or more of the IDF consensus worldwide definition of metabolic syndrome (2006), who agrees to participate in the study.

2.6 Exclusion Criteria

-Patients who do not fulfill the IDF criteria.

- Patients who refuse to participate in this study.

-Patients less than 18 years.

-Known cases of thyroid dysfunctions

2.7 Criteria for the Diagnosis of Metabolic Syndrome

Patients attending the referral clinic for their regular follow up were examined. Those who met the International Diabetes Federation (IDF) criteria for MetS were selected. Patients who have 3 positive criteria were chosen. Accordingly, 110 patients fulfilled the criteria. After obtaining informed consent from all the patients, personal data was reported from them. Then BP was checked and reported, waist circumference was measured. Body mass index (BMI) was calculated using the formula:

$$\text{BMI} = \text{weight in (Kg)} / \text{Height in (m}^2\text{)}$$

The patients' records of Fasting blood glucose, HbA_1c, triglyceride, high density lipoprotein were reported. Then blood samples were collected for testing for thyroid hormones.

2.8 Blood samples

After informed consent, blood sample was collected from the patients. A local antiseptic (70% ethanol) was used to clean the skin. Venous bloods of about (4ml) were withdrawn using a vacationer tube. The collection of blood sample was done by well trained lab assistant under supervision of senior lab technologist and medical doctor. The blood was drawn directly into a heparin vacationer tube; the blood sample was centrifuged for 15 minutes at 3000 rpm after that the serum was separated in a plain container and frozen until it was used for analysis of the thyroid function.

2.9 Methodology

•TSH was analyzed based on sandwich immune-enzymometric assay which is a two –site for the quantitative determination of the TSH, using TOSOH AIA system analyzer.

•FT4 was analyzed based on competitive enzyme immunoassay used for the quantitative determination of the FT4 using TOSOH AIA system analyzer .

•FT3 was analyzed based on competitive enzyme immunoassay used for the quantitative determination of FT3 using TOSOH AIA auto-analyzer.

2.10 Criteria for Diagnosing Thyroid Dysfunction

Normal TSH range 0.4- 4m IU, Normal FT_3 range 2.17-3.3pg/ml, Normal FT_4 range 0.82-2 ng/dl.

Overt hypothyroidism is diagnosed with high TSH associated with lower than normal FT_4, FT_3. Subclinical hypothyroidism is diagnosed with a high TSH>4m IU, in the presence of normal FT_4, FT_3.

Hyperthyroidism is diagnosed with low TSH< 0.4 mIU associated with high FT_4, FT_3. Subclinical hyperthyroidism is diagnosed with low TSH in the presence of normal FT_4, FT_3.

2.11 Statistical Analysis

SPSS software (version 16) was used for analysis of clinical variables.

3. Results

This chapter includes the description and presentation of our findings of the study population including the demographic features, components of metabolic syndrome, the levels of thyroid hormones detected by investigations, and the statistical analysis of the findings. The total number of patients who fulfilled the IDF criteria for metabolic syndrome was 114 patients.

3.1 Characteristics of the study population:

- In the 114 patients with MetS, the number of females was 84 (73.7%) patients and the number of males was 30 (26.3%), which showed female predominance. This is demonstrated in figure [1] and Table (1).

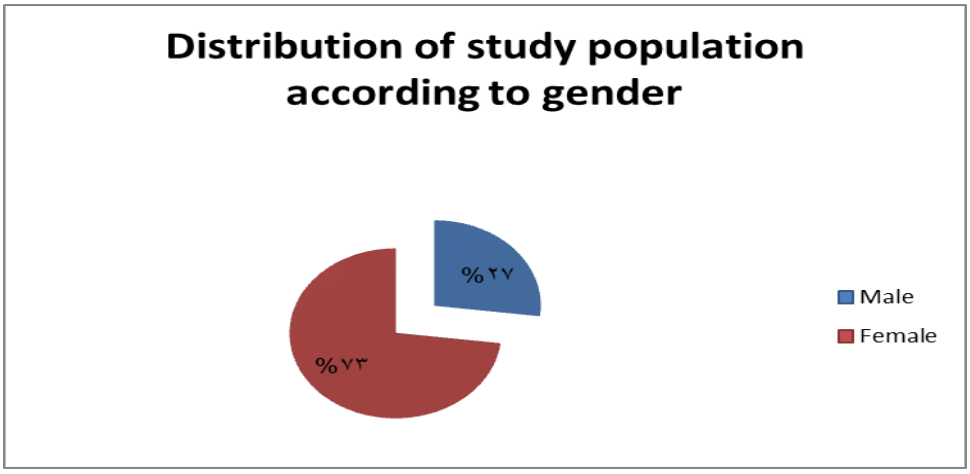

Figure 1

Table 1: Distribution of study population according to gender.

Gender	Number	Percent
Male	30	27
Female	84	73

- The origin of our patients is demonstrated in figure (2), which showed that most of our patients come from central and northern Sudan. Each region includes 36 patients, accounting for (34%) of the total patients. 30 (28.6%) patients come from eastern Sudan and only 12 (11.4%) patients from western Sudan. Figure[2].

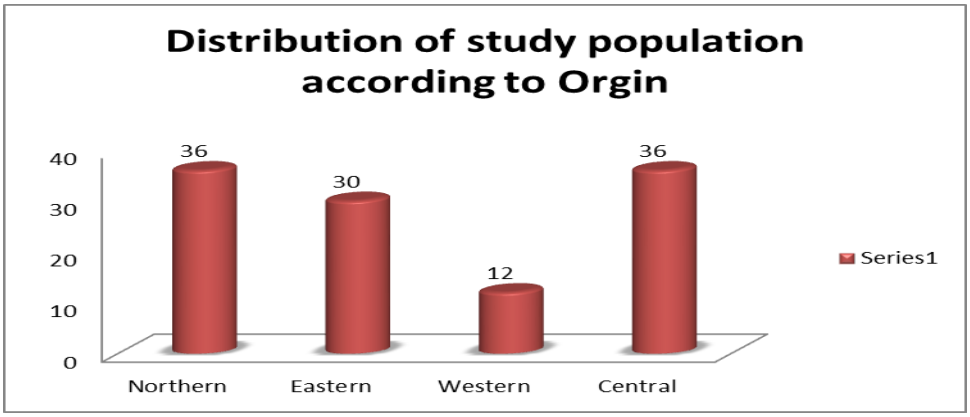

Figure 2

- The age range of our patients was (24-80) years. The mean age of males was 57.29±10.060. The mean age for females was (56.14±10.681) years. Table [2] and [3] demonstrate the distribution of the patients according to age.

Table 2: The Mean age distribution of Patients.

Age of study population			
Age (years	Mean± STD	Minimum	Maximum
	56.46± 10.48	24	80

Table 3: The Distribution of study population according to age.

Age of study populationaccording to gender (Mean± STD)			P.value
Age (years	Male(N=30)	Female (N=84)	0.342
	57.29±10.060	56.14±10.681	

3.2 The Prevalence of Thyroid Dysfunction

Abnormal TSH level was detected in 44 patients accounting for 38.6 % of the total number of patients. The distribution of thyroid status is demonstrated in figure [3]. Most of the patients with TD were females 30 patients representing 68% of the patients compared to males 14 patients (32%).

Most of the patients were euthyroid 70 patients (61.4%). Patients with overt hypothyroidism were 7(6.1%), hyperthyroidism was detected in 6 patients (5.3%), subclinical hypothyroidism in 15 patients (13.2%), and subclinical hyperthyroidism in 16 patients (14%), representing the most prevalent TD in these patients. Figure [3] showed the distribution of the study population according to thyroid functions

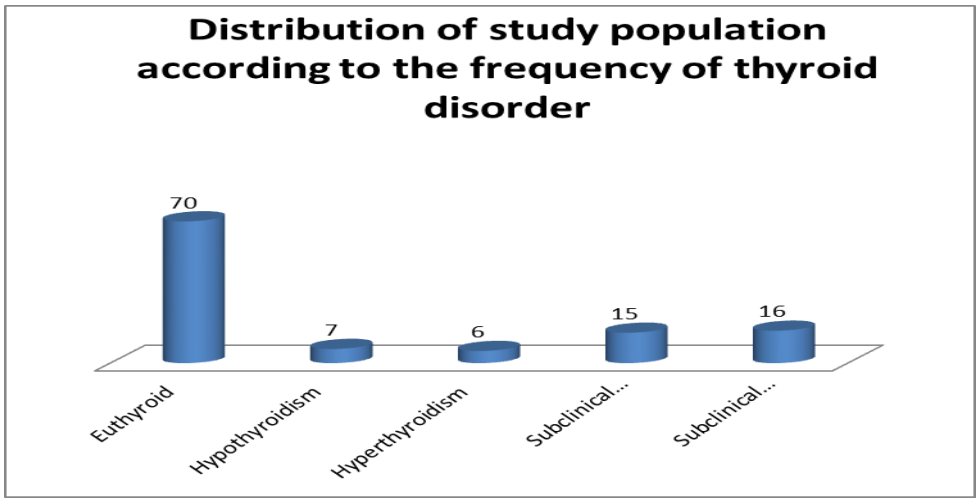

Figure 3

If we compare the mean level of thyroid hormones between males and females, we can see that females tend to

have higher normal TSH, FT_4 and FT_3 compared to males. This is shown in Table [4]. There is no statistically significant difference between the mean values in females and males.

Table 4: Comparison of thyroid profile according to Gender.

Parameter	Male (Mean ± SD)	Female Mean ±SD)
TSH(IU/ml	2.2±2.8	2.46±.69
FT4 ng/dl	0.93±0.39	1.08±.72
FT3	2.5±0.48	2.81±3.8

P value for TSH=0.439, FT_4= 0.71, FT_3=0.329

3.4The components of Metabolic Syndrome in the study population

Table [5] demonstrates a comparison of metabolic syndrome components in male and female patients. The females tend to have larger in mean BMI (31.6±5.4) compared to males (30.2±3.9), and higher level of HDL (36±8.1) compared to males (32.5±6.5). The male were found to have higher mean triglyceride (158.3±37.6) compared to females (149.5±40), and higher mean glycosylated hemoglobin (8.6±1.1) compared to females (8.4±1.2).

Table 5: Comparison of metabolic syndrome parameter according to Gender.

Parameter	Male (Mean ± SD)	Female Mean ±SD)
BMI(Kg/m^2)	30.2±3.9	31.6±5.4
Triglycerides(mg/dl)	158.3±37.6	149.5±40.6
HDL(mg/dl)	32.5±6.5	36.0±8.1
HbA1C (%)	8.6±1.1	8.4±1.2

Table [6] studies the frequency of different components of metabolic syndrome in the study population in addition to the body mass index (BMI).

Table 6: Distribution of study group according to Frequency of components of metabolic syndrome.

Metabolic syndrome component	**Range**	**Frequency(Number)**	**Percentage (%)**
Body Mass Index(kg/m^2)	25<30	31	27.2
	30<35	64	56.1
	35<40	10	8.8
	>40	9	7.9
Waist Circumference(cm)	88-90	5	4.4
	91- 95	12	10.5

	96-100	6	5.3
	101-105	23	20.2
	>106	68	59.6
Systolic Blood Pressure(mm/Hg)	<140	77	67.5
	>140	37	32.5
Diastolic Blood pressure(mm/Hg)	<90	78	68.4
	>90	36	31.6
Fasting Blood sugar(mg/dl)	>120	29	25.4
	121-150	52	45.6
	151-180	18	15.8
	>180	15	13.2
Triglycerides(mg/dl)	<150	63	55.3
	>150	51	44.7
High density lipoprotein(mg/dl)	<45	92	80.7
	>45	22	19.3

The table showed that:

- BMI range 30<35 was the most frequent weight range found in (64 patients) accounting for 56.1% of study group. They fall in obesity class 1 category according to WHO classification of BMI.
- Waist circumference more than 106 cm was the most frequent findings (68 patients) representing 59.6% of the study group.
- Most of the patients have systolic blood pressure ≤ 140 (77 patient) comprising 67.5% of the study group.
- Most of the patients have diastolic blood pressure of ≤ 90 (78 patients) representing 68.4% of the study group.
- Most of the patients (52) have a high fasting blood sugar range in the (121-150 mg/dl) comprising 45.6%of the study group. Very high levels of more than 180 mg/dl were found in 15 patients (13.2%)
- Triglyceride of more than 150mg/dl was found in most of the patients (63) accounting for 55.3% of the study group.
- Most of the patients demonstrated low levels of high density lipoprotein HDL 92 patients accounting for (80.7%).
- The most common component of metabolic syndrome in our study group is low HDL (in > 80%), followed by the large waist circumference (in 68%).

3.4 TSH level and the Components of Metabolic Syndrome

Pearson Correlation was used to determine the association between TSH level in the study population and the components of metabolic syndrome in the different thyroid status (euthyroid, hyperthyroid, and hypothyroid).The analysis showed that:

- The correlation was only significant between TSH and the BMI in the euthyroid group. This shown table [7].

Table 7: Correlation between TSH and Metabolic syndrome parameters in study group with euthyroidism.

Parameter	Statistic	HBA1C	BMI	TG	HDL
TSH	Pearson correllation	0.653	0.938*	-0.297	0.570
	Significant (two tail)	0.232	0.018	.627	.315

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

- There is a negative correlation between TSH level and glycated hemoglobin (HbA_1c) in patients with hyperthyroidism table [8].

Table 8: Correlation between TSH , Metabolic syndrome parameter in study group with Hyperthyroidism**.**

Parameter	Statistic	HBA1C	BMI	TG	HDL
TSH	Pearson correlation	-.001	-.724	-.162	-.484
	Significant (two tail)	.998	.066	.729	.271

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

- Patients with subclinical hypothyroidism showed negative correlation between TSH and the serum triglyceride level table [9].

Table 9: Correlation between TSH and , Metabolic syndrome parameter in study group with Subclinical hypothyroidism.

Parameter	Statistic	HBA1C	BMI	TG	HDL
TSH	Pearson correlation	0.380	-0.208	-0.038	0.165
	Significant (two tail)	0.162	0.457	0.894	0.556

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

- The TSH level in the patients with hypothyroidism and subclinical hyperthyroidism has no relation with the metabolic syndrome components table [10].

Table 10: Correlation between TSH and , Metabolic syndrome parameter in study group with Hypothyroidism.

Parameter	Statistic	HBA1C	BMI	TG	HDL
TSH	Pearson correlation	0.189	0.628	-0.304	0.350
	Significant (two tail)	0.720	0.182	0.558	0.497

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed)

ANOVA Method: In the last table [11], analysis of variance (ANOVA) was used for comparison of metabolic components according to thyroid status. The analysis demonstrated no significant correlation between the components of metabolic syndrome and the thyroid state.

Table 11: Comparison of metabolic Parameter in study group based on type of thyroid disorder**.**

Parameter	Euthyroid (Mean ±STD)	Hypothyroidism (Mean ±STD)	Hyperthyroidism (Mean ±STD)	Subclinical Hypothyroidism (Mean ±STD)	Subclinical Hyperthyroidism (Mean ±STD)	P. Value
BMI(kg/m$^{2)}$	31.6±5.3	28.5±2.9	28.6±3.2	30±4.9	31.6±4.2	0.385
HbA1c%	8.4±.9	9.5 ± 2.6	8.6± 1.7	7.6±2.0	8.5±0.79	0.144
Triglyceride(mg/dl)	152.5±39.	137.3± 37.5	168.8±45	145.1±37.8	159.94± 45.4	0.385
HDL(mg/dl)	34.3±7.75	35±6.0	34.3±4.7	37.5± 8.8	35.5±8.7	0.688

ANOVA method used for comparison between groups (P value is significant at level of (0.05).

4. Discussion

The present study evaluates the thyroid dysfunction in patients with metabolic syndrome in Sudanese patients. It enrolled 114 patients, taken from two centres in Khartoum. The patients were randomly chosen. All of them fulfill three or more of the IDF criteria for diagnosis of metabolic syndrome. Then these patients underwent blood investigations for TFT including TSH, FT_3, and FT_4.

In this study most of the patients with metabolic syndrome were found to be females (84 patients), equals to 73% of study population, as shown in table [1] and figure [1]. Some researchers in other studies report a higher incidence of the metabolic syndrome in women [5]whereas other studies show higher incidence of the syndrome in males. As stated in a review of sex differences in MetS, he reported an accumulating and emerging data that support significant heterogeneity that exists between men and women diagnosed with metabolic syndrome possibly due to hormonal regulation of body fat distribution and attendant metabolic abnormalities[6]. However, other studies demonstrated data from National Health and Nutrition Examination Survey (NHANES) (1999-2006) that indicate equal prevalence in both sexes (age adjusted prevalence 34.9% and 33.3% in men and women respectively [7]. Another possible cause for the female predominance in our study might be related to the ethnic origin.

Regarding the origin of the patients figure [2] most of the patients come from Northern and central regions of Sudan, possibly because these areas are close to these specialized centres.

The age range of our study population was 24-80 years Table [2], with an equal mean age of 56 in both males and females. This finding is similar to that of other study reported the age range (50-59)[12]. Most of the studies demonstrated increase prevalence of metabolic syndrome in all age groups; however the other study demonstrated that the most increased prevalence of metabolic syndrome is found in women in the young age group which is different from our study population[6].

The prevalence of thyroid dysfunction (TD) in the present study population was found to be 38.6%. This prevalence is higher than the prevalence of TD reported other area in which the prevalence are (28%), and (31.9%)[9,10]. The increased prevalence in Sudanese patients in the present study may be related to iodine deficiency this agree with previous study which described iodine deficiency disorders (IDD) throughout the urban areas in the Sudan due to iodine deficiency. [7]

Among the 44 patients with TD in this study group the females were 30 representing 68% of cases whereas the males were 14 patients (32%). The female dominance was also described in two different studies ,the first reported that 39.7% of patients were females compared with 26 % males, and the second study reported that 75% of patients were females versus 25% males.[9]

The main categories of thyroid status were shown in figure [3]. Most of the patients were found to be euthyoid (61.4%). Overt hypothyroidism was found in 6.1% of the study group which is much less than the frequency reported by another study which was 17.59% [9]. In our study the subclinical hypothyroidism was detected in 13.2% which is slightly higher than that of other study which reported that subclinical hypothyroidism was

8.1%. Also, the subclinical hyperthyroidism was the highest frequency in our study group 14% compared to 0.7% reported by same author. This finding is different from all of the reviewed studies all over the world that reported the subclinical hypothyroidism as the most prevalent TD among those with MetS. It could be due to other causes such as auto-antibodies or to abnormal iodine levels in these patients which was not measured in our study. [9]

In the present study cases with patients with overt hyperthyroidism constitute about 6.1% of the study group which is different from the findings reported by other studies the first study reported no case with overt hyperthyroidism[9] or another study which reported overt hyperthyroidism in a single case out of the 300 of the study group [10]. The high percentage of hyperthyroidism in our patients may be due to the presence of auto-antibodies [11].

Table [4] demonstrated a comparison between the mean levels of thyroid hormones in both males and females. It showed that there is higher mean level in all thyroid hormones in females' patients. This information may be of importance regarding the management of females with thyroid disorder.

The gender differences of the components of metabolic syndrome in our patients are shown in table [5]. The mean BMI was higher in females a finding similar to that reported by other [12]. The females in our study population also demonstrate tighter blood sugar control. This finding is different from that reported by mentioned study [12]. The females in our study group also tend to have lower TG and higher HDL levels which is disagree with the findings reported the by other study [9]

Table [6] demonstrates the frequency of different components of metabolic syndrome in the study population. About 60% of the study population have waist circumference of more than 106cm representing the second most common component of metabolic syndrome. Another study reported central obesity as the most prevalent component of metabolic syndrome in Moraccan patients [13]. Previous study also showed the central obesity was the most prevalent component in the study population [13]. The most prevalent component of MetS in our study group was the low HDL (80.7%), this finding is almost typical of that reported by other authors who reported low HDL in 82.78% of the population of Bamboutos Division, West region of Cameroon. Other metabolic components in our study population include High triglyceride in 55.3%, hyperglycaemia in 45.6%. High Systolic blood pressure detected in 32.5% and high diastolic blood pressure in 31.6%. [13,14]

The relation between TSH levels and the different components of metabolic syndrome was studied using Pearson Correlation. This is shown in table [11]. The analysis in our study population demonstrates a positive correlation between TSH level and the BMI in patients with euthyroid state, which was the only positive association.The positive correlation was found between TSH level and central obesity in the previous study [14]. The same authors also reported association between TSH level and HDL-C [14]. Another study showed high normal TSH level this had been significantly associated with the component of metabolic syndrome [15], but is different from the findings reported by others who found no association between TSH level and metabolic components in the euthyroid state [9].

Figure [8,9,10] demonstrate the relation between TSH level in the study group and the different components of metabolic syndrome. The statistical analysis showed no significant correlation between them. This is also true for the finding by others study which did not find association between TSH level and MetS components in euthyroid and subclinical hypothyroidism [16].

When ANOVA method was used in our study group to compare the different groups, table [15], the analysis demonstrates no association between the different groups of TD and the components of metabolic syndrome. This finding is similar to that reported in the study by other as they found no association between TSH level and metabolic syndrome or its components, HOMA-IR, serum insulin or serum high-sensitivity CRP (hs-CRP)[17]. The absence of correlation between TD and MetS components was also reported by another study using the same method of analysis as in our study [10].

4. Conclusion

- Thyroid dysfunction is a prevalent disorder in Sudanese patients with metabolic syndrome.
- Metabolic syndrome as well as thyroid dysfunction is more common in Sudanese women.
- The mean age affected by metabolic syndrome is 56 years in both sexes.
- The most prevalent thyroid dysfunction in Sudanese patients with metabolic syndrome is subclinical hyperthyroidism

5. Recommendations

- As thyroid disorders are common in patients with metabolic syndrome, screening tests for thyroid dysfunction are recommended in patients with metabolic syndrome (MetS).
- Patients' education and early detection and treatment of thyroid disorders in patients with metabolic syndrome (MetS) are vital to mitigate cardiovascular risks.
- Population based studies of thyroid dysfunction in patients with metabolic syndrome (MetS) for early detection and management.

6. Limitations of this study

Limitations of the study: this study was conducted in endocrine specialized centers with a small sample size , which might not reflect the real community statistics, however it draw our attention for the emerging global problem of obesity and metabolic syndrome and its complications. Also the study has been conducted in Sudan where recent studies showed that there is iodine deficiency all over the country, this fact may influence the results of thyroid blood tests. Other constrains to the study are lack of other thyroid investigations like thyroid auto -antibodies. Also the use of metformin in some patients participating in this study was not considered , a known effect of metformin on TFT is elevation of TSH.

References

[1]. Saklayen MG. The Global Epidemic of the Metabolic Syndrome. *Curr Hypertens Rep*. 2018;20(2):12.

[2]. Gregg EW, Shaw JE. Global health effects of overweight and obesity. N Engl J Med. 2017;377:80–1.

[3]. Ahmed MH, Ali YA, Awadalla H, Elmadhoun WM, Noor SK, Almobarak AO. Prevalence and trends of obesity among adult Sudanese individuals: Population based study. Diabetes Metab Syndr. 2017 Dec;11 Suppl 2:S963-S967. doi: 10.1016/j.dsx.2017.07.023. Epub 2017 Jul 11. PMID: 28736258.

[4]. AM Ahmed,BEH Elabid, KEH Elhassan and HA Waggiallah (2015).Metabolic Syndrome among Undergraduate Students Attending Medical Clinics for Obligatory Medical ScreeningTrop J Pharm Res, February 2015; 14(2): 317

[5]. N.Senthil, Sneha Thomas, P. Santosh, Sujatha, S, (2015),"A study of prevalence of thyroid dysfunction in patients with metabolic syndrome" International Journal of Research in Medical Sciences, Vol5,No 11 (2015).DOI: https://dx.doi.org/1018203/2320-6012.ijrms20151157

[6]. Pardhan D. Aruna, (2013)," Sex Diffrences in the Metabolic Syndrome: Implication for Cardiovascular Health in Women", *Clinical Chemistry*, Vol 60, November 19, 2013- 11:04. Doi: https://doi.org/10.1373/clinichem.2013.20

[7]. Abdel Monim MH Medani, Abdelsalam A Elnour, Amal M Saeed (2011)," Endemic goitre in the Sudan despite long-standing programmes for the control of iodine deficiency disorders", *Bulletin of the World Health Organization*, 2011 Feb 1;89 (2) : 121-126.

[8]. SaojKhatiwada, Santosh Kumar Sah, […],andMadhabLamsal, (2016), "Thyroid dysfunction in Metabolic Syndrome patients and its relationship with components of metabolic syndrome", *Clin Diabetes Endocrinol*. 2016; 2:3

[9]. .VaishaliDeshmukh, FaazFarishta, MilindBhole, (2018),"Thyroid Dysfunction in Patients with Metabolic Syndrome: A Cross-Sectional, Epidemiological, Pan-Indian Study" ,*International Journal of Endocrinology*, Volume 2018, Article ID 2930251, 6 pages.https://doi.org/10.1155/2018/293025110

[10]. PrabinGyawali, Jyoti Shrestha Takanche, Raj Kumar Shrestha, PremBhattarai,(2015)," Patterns of Thyroid Dysfuncton in Patients with Metabolic Syndrome and Its Relationship with Components of Metabolic Syndrome", *Diabetes & Metabolism Journal*, 39 (1):66-37

[11]. N.Senthil, Sneha Thomas, P. Santosh, Sujatha, S, (2015),"A study of prevalence of thyroid dysfunction in patients with metabolic syndrome" International Journal of Research in Medical Sciences, Vol5,No 11 (2015).DOI: https://dx.doi.org/1018203/2320-6012.ijrms20151157

[12]. .Muhammad Ahmed Alamgir, Riz Ahmed Javid, {…}, IrumMustfa, (2015)" Gender differences in components of metabolic syndrome mong patients of type 2 dibetes", *Pak J Med Sci*, 2015 Jul-Aug; 31(4):886-890

[13]. Otmane El Brini, Omar Akhouayri,[…], BouchraBenazzouz, (2014)," Prevalence of metabolic syndrome and its components in based on a harmonious definition among adults in Morocco", *Diabetes MetabSyndr Obes*.2014; 7: 541-348

[14]. Wenzhen Li, Dongming, Wang, […]Zuxun Lu ,(2019)," The association of metabolic syndrome components and diabetes mellitus: evidence from China National Stroke Screening and Prevention Project", *BMC Public Health*, 19, article number:192 (2019)

[15]. LilitPetrosyn, ( ),"Relationship between high normal TSH levels and metabolic syndrome in type 2

diabetic subjects witheuthyroidism", *J ClinTransiEndocrinol*. 2015 Sep; 2(3):110-113

[16]. Mehran, Ladan, Amouzergar, Atieh; Azizi, Fereidoun,"Thyroid disease and the metabolic syndrome", *Current Opinion in Endocrinology, Diabetes and Obesty: October 2019-Volume 26 Issue 5-P256-265*

[17]. Luis Raposa, Sandra Martin, […], Ana Cristina Santos, (2019),"Metabolic Syndrome, Thyroid Function and Autoimmunity-The PORMET Study",EndocrMetab Immune Disord Drug Target.