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ORIGINAL RESEARCH

To determine the frequency of thyroid impairment in individuals with metabolic syndrome

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ABSTRACT

Aim: To Determine the frequency of thyroid impairment in individuals with metabolic syndrome. **Materials and Methods:** It comprised a total of 100 patients who were matched for age and sex (50 cases and 50 controls). Patients exhibiting central adiposity, defined as a waist circumference of 90 cm or more in males and 80 cm or more in females, together with serum triglyceride levels of 150 mg/dl or more, serum HDL cholesterol levels below 40 mg/dl in men and below 50 mg/dl in women, and abnormal blood pressure: This research comprised individuals with a systolic blood pressure of 130 mmHg or higher, or a diastolic blood pressure of 85 mmHg or higher, as well as a fasting plasma glucose concentration of 100 mg/dl or higher.Cases: Subjects fulfilling the criteria for MetS were included as cases.Controls: Apparently normal and healthy subjects without MetS were considered as controls. **Results:**The average T3 level in male controls was 1.45±0.86, whereas in cases it was 1.65±0.84. However, this difference is not statistically significant (p=0.13). The average T3 level in female controls was 1.77±2.21, whereas in cases it was 1.83±0.13. However, the difference between the two groups is not statistically significant (p = 0.24). The average T4 level in male controls was 10.03±2.58, whereas in cases it was 9.05±3.12. However, this difference is not statistically significant (p = 0.21). The average T4 level in female controls was 10.04±2.01, but in cases it was 9.14±1.76. However, this difference is not statistically significant (p = 0.31). The average TSH level in male controls was 1.76±2.33, whereas in cases it was 4.52±4.11, showing a statistically significant difference (p=0.03). The average TSH level in female controls was 2.11±2.47, but in cases it was 7.23±8.88, showing a statistically significant difference (p = 0.04). The tables are labeled as Table 1 and Table 2. **Conclusions:** Thyroid dysfunction, namely subclinicalhypothyroidism, is prevalent in individuals with metabolic syndrome and is linked to some aspects of metabolic syndrome.

Keywords: Thyroid, Metabolic syndrome, T3, TSH

INTRODUCTION

Metabolic syndrome, a recognized combination of cardiovascular risk factors, is a significant global public health issue [1, 2]. Metabolic syndrome elevates the likelihood of developing cardiovascular disease, diabetes, and certain forms of cancer [3]. Metabolic syndrome, as defined by the National Cholesterol Education Program's Adult Treatment Panel III, refers to the presence of abnormal values in at least three of the following criteria: waist circumference, serum triglycerides, high-density lipoprotein (HDL) cholesterol, blood pressure, and fasting glucose [3]. The incidence of metabolic syndrome is seeing a substantial rise [4]. Based on data from the National Health and Nutrition Examination Survey (NHANES) 2011–2012, about 34.7% of individuals in the United States were estimated to have metabolic syndrome [4]. Europe and other nations have also seen similar upward trends [2, 5]. In 2012, the prevalence of metabolic syndrome in the general population of Korea was around 28.2%, as determined by the National Cholesterol Education Program's Adult Treatment Panel III criteria and the World Health Organization Asia-Pacific recommendations [6]. The death rate attributed to cardiovascular disease has risen from

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35.6 to 52.4 per 100,000 individuals during the years 2003 and 2014. Therefore, it is essential to prioritize and exert greater effort towards decreasing the occurrence of metabolic syndrome, taking into account the alarming rise in death rates associated with connected illnesses [7].

Thyroid hormones have a crucial function in metabolism [8]. Deviant levels of thyroid hormones disrupt metabolism, and several of these alterations exhibit shared pathophysiologic mechanisms with metabolic syndrome. Thus, thyroid dysfunction has the potential to impact metabolic syndrome. Lambadiari et al. found that thyroid hormones play a crucial role in maintaining glucose balance and influence fasting glucose levels by counteracting the effects of insulin. Hyperthyroidism causes a decrease in insulin secretion, which reduces the synthesis of glucose in the liver and increases glucose absorption in the muscles [9]. Similarly, Dimitriadis et al. demonstrated that the elevated glucose levels in hyperthyroidism may be attributed to an augmentation in the body's own glucose synthesis by gluconeogenesis [10]. Research has also shown a connection between thyroid hormones and glucose levels. Klein et al. conducted a comprehensive evaluation of many research that investigated the mechanism by which thyroid hormones affect the cardiovascular system [11]. The researchers determined that thyroid hormones have both direct and indirect effects on the cardiovascular system. Patients with thyroid illness, particularly hyperthyroidism, may exhibit indications and manifestations of cardiovascular alterations [11]. Multiple further investigations have shown that overt hypothyroidism causes a rise in both blood pressure and plasma cholesterol levels [12]. The present research is to examine the frequency of thyroid dysfunction in individuals with metabolic syndrome and to explore the correlation between thyroid abnormalities and the various components of metabolic syndrome.

MATERIALS AND METHODS

The research was initiated and ethical approval was received from the Institutional ethics committee. This research was a cross-sectional study conducted in a hospital setting. It comprised a total of 100 patients who were matched for age and sex (50 cases and 50 controls). The age range of the subjects was between 30 and 50 years. Thorough and accurate informed permission was obtained from all the participants.Patients exhibiting central adiposity, defined as a waist circumference of 90 cm or more in males and 80 cm or more in females, together with serum triglyceride levels of 150 mg/dl or more, serum HDL cholesterol levels below 40 mg/dl in men and below 50 mg/dl in women, and abnormal blood pressure: This research comprised individuals with a systolic blood pressure of 130 mmHg or higher, or a diastolic blood pressure of 85 mmHg or higher, as well as a fasting plasma glucose concentration of 100 mg/dl or higher.

Cases: Subjects fulfilling the criteria for MetS were included as cases.

Controls: Apparently normal and healthy subjects without MetS were considered as controls.

This research included subjects who were being treated for thyroid problems and dyslipidemia, as well as those using medications that affect glucose and thyroid hormone metabolism, such as steroids and antipsychotics. Pregnant individuals and those with significant hepatic, renal, or cardiovascular illness were also included.

Anthropometry: The waist circumference was assessed by placing a non-elastic measuring tape parallel to the floor, at the location midway between the bottom edge of the lowest palpable rib and the top of the iliac crest, while the individual was exhaling normally. Following a 15-minute period of rest, blood pressure (BP) was assessed as systolic blood pressure (SBP) and diastolic blood pressure (DBP) in the right upper limb using a sphygmomanometer while the individual was lying down, with the sphygmomanometer positioned at the same level as the heart.

Biochemical tests: Anterior cubital vein venipuncture was used to obtain fasting morning blood samples (5ml) in a simple red top vacutainer for serum separation. The sample was allowed to coagulate for a duration of 15 minutes. The samples were subjected to centrifugation in order to separate the serum and thereafter examined. The measurement of fasting glucose was conducted using the GOD-POD technique. The enzymatic CHOD/POD technique was used to detect serum cholesterol. The measurement of Serum HDL-C was determined using the direct technique. The concentration of serum triglyceride was determined using the Glycerol Phosphate Oxidase/Peroxidase (GPO/POD) colorimetric endpoint technique. LDL-C was obtained using Friedwald's formula as given below:

LDL-C = Total cholesterol – (HDL-C + VLDL- C). 12 TSH, Total T3 and Total T4: were estimated by Chemiluminescence immunoassay (CLIA) using neolumax.

STATISTICAL METHODS

The data was evaluated using the SPSS tool, namely version 20, by performing suitable statistical tests.

The data was presented in terms of the mean value plus or minus the standard deviation. The Student's t-test was used to assess the disparity between the two cohorts within the population. A significance level of less than 0.05 was used to determine statistical significance.

RESULTS

Cross-sectional research was conducted in a hospital setting to examine the occurrence of thyroid dysfunction among men and females, both with and

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without metabolic syndrome. The average waist circumference (WC) in male controls was 89.52 ± 2.03, whereas cases had a WC of 102.83 ± 5.94, showing a statistically significant difference ($p < 0.001$). The mean waist circumference (WC) in female controls was 77.86 ± 3.91, whereas in cases it was 93.82 ± 7.84, showing a very significant statistical difference ($p < 0.001$) (Tables 1 and 2). The mean systolic blood pressure (SBP) in male controls was 119.65 ± 8.09, whereas in cases it was 128.52 ± 11.49. There was a significant statistical difference between the two groups (p=0.002). The mean systolic blood pressure (SBP) in female controls was 115.58 ± 10.24, whereas in cases it was 124.55 ± 16.67, showing a statistically significant difference (p=0.006). (Tables 1 and 2). The mean diastolic blood pressure (DBP) in male controls was 80.10 ± 7.16, but in cases it was 83.71 ± 9.23, showing a statistically significant difference ($p = 0.01$). The mean diastolic blood pressure (DBP) in female control subjects was 73.67±9.11, whereas in cases it was 82.71±10.22, showing a statistically significant difference ($p = 0.004$). (Tables 1 and 2). The mean FPG in male controls was 94.93±13.21, whereas in cases it was 112.77±19.81. There was a significant statistical difference between the two groups ($p = 0.002$). The mean FPG in female controls was 91.44±9.43, whereas in cases it was 108.91±15.41, showing a statistically significant difference ($p = 0.001$). (Tables 1 and 2). The mean triglyceride (TG) level in male controls was 127.26±50.12, but in cases it was 181.62±90.07. There was a significant statistical difference between the two groups ($p = 0.002$). The mean triglyceride (TG) level in female controls was 102.97±29.24, but in cases it was 157.64±87.18. There was a significant statistical difference between the two groups (p=0.002). (Tables 1 and 2). The average high-density lipoprotein (HDL) level in healthy males was 41.28±5.82, whereas in those with the condition it was 36.82±3.98. There was a significant statistical difference between the two groups ($p = 0.03$). The average HDL-C level in female controls was 48.41±7.88, whereas in cases it was 40.36±7.24, showing a statistically significant difference ($p = 0.002$). (Tables 1 and 2). The average T3 level in male controls was 1.45±0.86, whereas in cases it was 1.65±0.84. However, this difference is not statistically significant (p=0.13). The average T3 level in female controls was 1.77±2.21, whereas in cases it was 1.83±0.13. However, the difference between the two groups is not statistically significant ($p = 0.24$). (Tables 1 and 2). The average T4 level in male controls was 10.03±2.58, whereas in cases it was 9.05±3.12. However, this difference is not statistically significant ($p = 0.21$). The average T4 level in female controls was 10.04±2.01, but in cases it was 9.14±1.76. However, this difference is not statistically significant ($p = 0.31$). (Tables 1 and 2). The average TSH level in male controls was 1.76±2.33, whereas in cases it was 4.52±4.11, showing a statistically significant difference (p=0.03). The average TSH level in female controls was 2.11±2.47, but in cases it was 7.23±8.88, showing a statistically significant difference ($p = 0.04$). The tables are labeled as Table 1 and Table 2.

Table 1: Comparative study of male cases with controls

Males Parameters	Controls	Cases	P Value
	MEAN ±SD	MEAN± SD	
WC(cm)	89.52±2.03	102.83 ±5.94	0.001
SBP(mm of Hg)	119.65 ±8.09	128.52±11.49	0.002
DBP(mm of Hg)	80.10± 7.16	83.71±9.23	0.01
FBS(mg/dl)	94.93± 13.21	112.77±19.81	0.002
TG(mg/dl)	127.26±50.12	181.62±90.07	0.002
HDL(mg/dl)	41.28±5.82	36.82±3.98	0.03
T3(ng/ml)	1.45±0.86	1.65±0.84	0.13
T4 (µg/dl)	10.03±2.58	9.05±3.12	0.21
TSH (mIU/L)	1.76±2.33	4.52±4.11	0.03

Table 2: Showing comparative study of female cases with controls

Females Parameters	Controls	Cases	P Value
	MEAN ±SD	MEAN ±SD	
WC(cm)	77.86±3.91	93.82±7.84	0.001
SBP(mm of Hg)	115.58±10.24	124.55±16.67	0.006
DBP(mm of Hg)	73.67±9.11	82.71±10.22	0.004
FBS(mg/dl)	91.44±9.43	108.91±15.41	0.001
TG(mg/dl)	102.97±29.24	157.64±87.18	0.002
HDL(mg/dl)	48.41±7.88	40.36± 7.24	0.002
T3(ng/ml)	1.77±2.21	1.83±0.13	0.24
T4 (µg/dl)	10.04±2.01	9.14±1.76	0.31
TSH (mIU/L)	2.11±2.47	7.23±8.88	0.04

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Table 3: Prevalence of thyroid dysfunction in males

	Cases		Controls		Total	
	Number	**Percentage (%)**	**Number**	**Percentage(%)**	**Number**	**Percentage(%)**
Thyroid dysfunction	8	32	4	16	12	24
Euthyroid	17	68	21	84	38	76
Total	25	100	25	100	50	100

Table 4: Prevalence of thyroid dysfunction in females

	Cases		Controls		Total	
	Number	**Percentage (%)**	**Number**	**Percentage (%)**	**Number**	**Percentage (%)**
Thyroid dysfunction	7	28	3	12	10	20
Euthyroid	18	72	22	88	40	80
Total	25	100	25	100	50	100

Table 5: Prevalence of thyroid dysfunction in males and females combined

	Cases		Controls		Total	
	Number	**Percentage (%)**	**Number**	**Percentage (%)**	**Number**	**Percentage (%)**
Thyroid dysfunction	15	30	7	14	22	22
Euthyroid	35	70	43	86	78	78
Total	50	100	50	100	100	100

DISCUSSION

Recent research conducted on the adult population in India found that the incidence of hypothyroidism was 3.9%, while the prevalence of subclinical hypothyroidism was 9.4%. Shantha et al. reported that the MetS group had a prevalence of 7.4% for overt hypothyroidism and 21.9% for subclinical hypothyroidism[12].The research found a higher frequency of thyroid dysfunction in females compared to men, which is consistent with the findings of the study conducted by Uzunlulu et al[13]. Hence, we suggest regularly assessing thyroid function in patients with Metabolic Syndrome (MetS), especially in females.

This research demonstrated a noteworthy correlation between thyroid dysfunction and Metabolic Syndrome (MetS) in both men and females (P = 0.004). There was a notable disparity in the average values of many physical and chemical measurements between patients with Metabolic Syndrome (MetS) and healthy individuals. However, the levels of T3 and T4 hormones did not show any significant changes. Therefore, it was shown that thyroid dysfunction is associated with all the components of Metabolic Syndrome (MetS). The results of this study were consistent with those reported by Kota et al., who found that individuals with metabolic syndrome (MetS) had significantly higher levels of body mass index (BMI), waist circumference (WC), mean systolic blood pressure (SBP), diastolic blood pressure (DBP), fasting blood glucose (FBG), total cholesterol, low density lipoprotein cholesterol (LDL-C), triglycerides (TG), and thyroid stimulating hormone (TSH) compared to the control group. Additionally, the study group had significantly lower levels of high density lipoprotein cholesterol (HDL-C). Meher et al[15] did a research that yielded similar results.

In our investigation, we did not see any association between TSH and any of the components of MetS. The research conducted by Wang et al. [16] revealed no significant statistical association between subclinical thyroid illness and MetS, in contrast to the notable link observed in the study by Kim et al. [17]. In this investigation, we observed no instances of hyperthyroidism, which differs from the findings of Jayakumar[18].Both the systolic and diastolic blood pressure levels were seen to be considerably elevated in women with subclinical hypothyroidism. There was a positive association seen between TSH levels and blood pressure. A positive linear correlation was found in a comprehensive population research between systolic and diastolic arterial pressure and TSH levels[19]. Hypothyroidism may elevate peripheral vascular resistance and stimulate the sympatho-adrenal system, resulting in a rise in blood pressure, especially diastolic blood pressure[20]. Insulin resistance is the primary pathological factor that drives the development of metabolic syndrome. It is also the main contributing factor for the progression of type 2 diabetes mellitus (T2DM), dyslipidemia, and thyroid dysfunction. This correlation between insulin and TSH (thyroid-stimulating hormone) was confirmed by Singh BM et al in their study, indicating a significant relationship between the two. Bakker et al. established a correlation between insulin resistance and thyroid function in non-diabetic persons with normal thyroid levels. According to their data, insulin resistance worsens the negative impact of hypothyroidism on the lipid profile. This indicates a connection between insulin resistance and low levels of HDL-C and elevated levels of TGs in the blood[22-26].

TSH serum levels serve as a dependable indicator of the biological functioning of thyroid hormones. Several studies have shown that both adipocytes and

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preadipocytes possess TSH receptors, which may bind to TSH and stimulate preadipocytes to generate and release adipokines such as leptin. This process plays a significant role in the development of metabolic syndrome and cardiovascular disease[27]. Leptin controls the expression of TRH, whereas insulin raises the overall levels of Leptin[28-31]. Therefore, the presence of excess fat in the abdomen region, together with insulin resistance, might potentially lead to elevated levels of thyroid-stimulating hormone (TSH) in the bloodstream due to higher concentrations of leptin in the blood.

Overall, there is a significant occurrence of thyroid malfunction, namely Subclinical Hypothyroidism, among individuals with Metabolic Syndrome (MetS), with females being particularly vulnerable to this condition. While thyroid hormones have a major impact on each aspect of Metabolic Syndrome (MetS), no correlation was shown between thyroid dysfunction and all of the individual components of MetS. There is a higher occurrence of thyroid malfunction, namely an increase in TSH levels with normal T4 and T3 levels, among individuals with Metabolic Syndrome (MetS). Moreover, the simultaneous presence of both disease entities might significantly elevate the likelihood of developing Arterio Sclerotic Cardio Vascular Disease (ASCVD). Therefore, it is advisable to request TSH and fT4 level tests for all patients with Metabolic Syndrome (MetS).

CONCLUSIONS

This study underscores the significant association between thyroid dysfunction, particularly subclinical hypothyroidism, and metabolic syndrome (MetS). Our findings reveal that thyroid dysfunction is more prevalent among individuals with MetS, with a notably higher incidence in females. Despite the lack of significant changes in T3 and T4 levels, elevated TSH levels were prevalent, indicating thyroid dysfunction. This dysfunction is correlated with several components of MetS, such as increased waist circumference, blood pressure, fasting glucose, and triglycerides, and decreased HDL levels. Given the interplay between thyroid hormones and metabolic parameters, routine screening for thyroid function in MetS patients, especially among females, is recommended. Identifying and managing thyroid dysfunction in MetS patients is crucial for mitigating the risk of cardiovascular diseases and improving overall metabolic health. Regular monitoring and appropriate treatment of thyroid dysfunction can play a pivotal role in managing MetS effectively.

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