

Comparative Study of Subclinical Hypothyroidism in Patients with and Without Metabolic Syndrome

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Abstract:

Background: A group of metabolic abnormalities known as metabolic syndrome (MetS) greatly raises the risk of type 2 diabetes mellitus and cardiovascular illnesses. People with MetS frequently have subclinical hypothyroidism (SCH), which is defined by high levels of thyroid-stimulating hormone (TSH) with normal free thyroxine (T4). The research examined the relationship between thyroid function and metabolic parameters, as well as to assess the incidence of subclinical hypothyroidism in individuals with and without MetS.

Methods: There were 960 participants in all, 480 of whom had a diagnosis of MetS and 480 of whom were healthy controls. Blood pressure and waist circumference were measured clinically. After an overnight fast, blood samples were taken utilising fully automated clinical chemistry and hormone analyzers to assay lipid profile, fasting blood glucose (FBG), and thyroid function tests (T3, T4, and TSH). The Pearson correlation coefficient and Student's t-test were used to analyse the data.

Results: Statistically, there was a significant variation in the prevalence of subclinical hypothyroidism between the MetS group (16.3%) and the control group (5%; $p < 0.001$). In addition to having decreased HDL cholesterol, MetS patients also had higher FBG, blood pressure, triglycerides, and waist circumference. TSH levels and the elements of MetS, such as waist circumference ($r = 0.41$, $p < 0.001$), systolic blood pressure ($r = 0.38$, $p < 0.001$), FBG ($r = 0.44$, $p < 0.001$), triglycerides ($r = 0.39$, $p < 0.001$), and HDL cholesterol ($r = -0.32$, $p < 0.001$), were found to be significantly correlated with each other.

Conclusion: The results of the study indicate that people with metabolic syndrome have a higher incidence of subclinical hypothyroidism, which may indicate a relationship between thyroid function and metabolic health. Regular thyroid function testing could help improve clinical outcomes by enabling early detection and management of SCH in MetS patients.

Recommendations: When treating patients with metabolic syndrome, healthcare professionals should think about doing routine thyroid function tests. To manage thyroid dysfunction in

patients with metabolic syndrome (MetS), further research is required to investigate the underlying mechanisms and create tailored therapies.

Keywords: Metabolic Syndrome, Subclinical Hypothyroidism, Thyroid Function, Cardiovascular Risk, Metabolic Health

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Introduction

A collection of related metabolic illnesses, including obesity, hypertension, dyslipidemia, and insulin resistance are collectively referred to as metabolic syndrome (MetS). It greatly increases the chance of getting type 2 diabetes mellitus (T2DM) and cardiovascular illnesses. The rising incidence of obesity and sedentary habits has made metabolic syndrome (MetS) a major global public health issue. Recent research indicates that MetS is becoming more commonplace globally, impacting about one-third of individuals in affluent nations and a growing number in developing areas [1].

An high serum level of thyroid-stimulating hormone (TSH) combined with normal levels of free thyroxine (T4) is known as subclinical hypothyroidism (SCH). It is a prevalent endocrine condition, especially in elderly adults and women. SCH is frequently asymptomatic, but it can develop into overt hypothyroidism and is linked to a number of harmful health outcomes, such as dyslipidemia and cardiovascular disorders [2]. There may be a connection between metabolic syndrome and schizophrenia-like symptoms (SCH); research indicates that those with SCH are more likely to have characteristics of MetS [3].

The interplay between thyroid function and metabolic health is complex. Thyroid hormones play a critical role in regulating metabolism, influencing lipid and glucose metabolism, and maintaining energy balance. Dysregulation of thyroid function can thus have profound effects on metabolic processes. Conversely, metabolic disturbances such as those seen

in MetS can impact thyroid function, creating a bidirectional relationship [4].

Recent research have emphasized the importance of identifying and managing SCH in patients with MetS. For instance, a study found that SCH is associated with an increased risk of MetS, independent of other risk factors [5]. Similarly, research demonstrated that thyroid dysfunction, particularly elevated TSH levels, correlates with the severity of MetS components, suggesting that SCH may exacerbate metabolic abnormalities [6].

Despite growing evidence of the relationship between SCH and MetS, there remains a need for comprehensive studies to further elucidate this relationship and its clinical implications. Understanding the prevalence of SCH in MetS patients and its impact on metabolic parameters could inform targeted screening and intervention strategies.

This study aims to compare the prevalence of subclinical hypothyroidism in patients with and without metabolic syndrome, providing insights into the potential need for routine thyroid function screening in MetS patients.

Methodology

Study Design

A comparative cross-sectional design.

Study Setting

The study was conducted at S. C. B. Medical College & Hospital, Cuttack, Odisha, from April 2023 to March 2024.

Participants

A total of 80 patients per month were recruited for the study. The study aimed to include 960 participants in total, divided into two groups: 480 cases with metabolic syndrome (MetS) and 480 controls without MetS.

Inclusion Criteria

- Patients diagnosed with metabolic syndrome based on the NCEP ATP III criteria.
- Controls without metabolic syndrome.
- Participants aged 18-65 years.
- Both male and female participants.

Exclusion Criteria

- Patients with diabetes-related complications.
- Individuals with liver and renal dysfunction.
- Patients on corticosteroids or other medications that alter lipid, glucose, or thyroid parameters.
- Pregnant women.
- Individuals with a history of cardiovascular disease.

Sample Size

To calculate the sample size for this study, the following formula was used for estimating a proportion in a population:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:

- n = sample size
- Z = Z-score corresponding to the desired level of confidence
- p = estimated proportion in the population
- E = margin of error

Bias

To minimize bias, the study implemented random selection of participants, ensured blinding of laboratory personnel to group

allocations, and standardized measurement techniques and protocols.

Variables

The study examined independent variables, including the presence of metabolic syndrome, waist circumference, and blood pressure, and their impact on dependent variables like thyroid function tests (T3, T4, TSH), fasting blood glucose (FBG), and lipid profiles (triglycerides, HDL cholesterol).

Data Collection

Data collection involved several key steps to ensure accuracy and reliability of the results. Waist circumference was measured using a standard measuring tape, and blood pressure was recorded using a calibrated sphygmomanometer. Blood samples were then collected from participants after an overnight fast, ensuring that the samples were taken under strict aseptic conditions to prevent contamination. These samples were then assayed for FBG and lipid profile using enzymatic assays on a fully automated clinical chemistry analyzer, which provided precise and consistent measurements essential for the study's analysis.

Procedure

- Waist circumference was measured using a measuring tape.
- Blood pressure was recorded using a sphygmomanometer.
- Participants were instructed to fast overnight before blood sample collection.
- A 5ml blood sample was drawn from each participant and placed in plain vacutainers.
- Blood samples were centrifuged, and serum was assayed for FBG and lipid profile.
- Thyroid function tests (T3, T4, TSH) were analyzed using chemiluminescence assay on an Access-2 hormone analyzer.

- Quality control measures, including internal and external programs, were routinely implemented to ensure assay accuracy.

Statistical Analysis

The metabolic syndrome components were represented as the mean \pm standard deviation (SD). The significance of the differences between the groups was assessed using the Student t-test. Thyroid function tests and components of the MetS were compared using the Pearson correlation coefficient. At $p < 0.05$, statistical significance was established.

Ethical Considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

A total of 960 participants were recruited over 12 months, with 480 participants diagnosed with MetS and 480 healthy controls. The mean age was 45.3 ± 10.2 years, with 54% males and 46% females.

Table 1: Clinical Features and Metabolic Parameters

Parameter	MetS Group	Control Group	p-value
Age (years)	46.1 \pm 9.8	44.5 \pm 10.6	0.03
Waist circumference (cm)	105.4 \pm 12.2	85.7 \pm 9.3	<0.001
Systolic BP (mmHg)	142.6 \pm 18.4	120.5 \pm 12.7	<0.001
Diastolic BP (mmHg)	90.8 \pm 11.3	75.4 \pm 9.6	<0.001
Fasting blood glucose (mg/dL)	116.7 \pm 22.5	88.9 \pm 9.7	<0.001
Triglycerides (mg/dL)	178.3 \pm 35.6	121.5 \pm 24.3	<0.001
HDL cholesterol (mg/dL)	38.4 \pm 8.5	52.7 \pm 10.2	<0.001
T3 (ng/dL)	1.2 \pm 0.3	1.3 \pm 0.2	0.04
T4 (μ g/dL)	8.4 \pm 1.6	8.7 \pm 1.5	0.09
TSH (μ IU/mL)	4.7 \pm 1.8	2.6 \pm 1.2	<0.001

Among the MetS group, 78 participants (16.3%) were diagnosed with subclinical hypothyroidism, while only 24 participants (5%) in the control group had subclinical hypothyroidism. This variation was statistically significant ($p < 0.001$).

Pearson correlation analysis showed significant correlations between TSH levels and the components of metabolic syndrome (Table 2).

Table 2: Correlation between Metabolic Syndrome Components and Thyroid Function

Parameter	Correlation with TSH (r)	p-value
Waist circumference (cm)	0.41	<0.001
Systolic BP (mmHg)	0.38	<0.001
Diastolic BP (mmHg)	0.35	<0.001
Fasting blood glucose (mg/dL)	0.44	<0.001
Triglycerides (mg/dL)	0.39	<0.001
HDL cholesterol (mg/dL)	-0.32	<0.001

Table 3: Comparison of Thyroid Function between Groups

Thyroid Function Test	MetS Group	Control Group	p-value
T3 (ng/dL)	1.2 \pm 0.3	1.3 \pm 0.2	0.04
T4 (μ g/dL)	8.4 \pm 1.6	8.7 \pm 1.5	0.09

TSH (μ IU/mL)	4.7 ± 1.8	2.6 ± 1.2	<0.001
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Discussion

With 960 participants, split equally between 480 instances of MetS and 480 controls, the study examined the incidence of subclinical hypothyroidism in patients with MetS compared to healthy controls. Subclinical hypothyroidism was detected in 16.3% of the MetS group, according to the research, which is significantly higher than the 5% of the control group that had the same condition ($p < 0.001$). This significant distinction suggests a possible link between subclinical hypothyroidism and MetS.

In comparison to controls, individuals with MetS had significantly higher waist circumference, FBG, systolic and diastolic blood pressure, and triglycerides, as well as lower HDL cholesterol levels, according to a detailed analysis of clinical and metabolic characteristics. The MetS group also showed increased TSH levels, which may indicate compromised thyroid function. These results, which highlighted the metabolic abnormalities in MetS patients, were statistically significant.

Correlation analysis between TSH levels and components of MetS revealed significant positive correlations with waist circumference, FBG, systolic and diastolic blood pressure, and triglycerides. Conversely, HDL cholesterol showed a negative correlation with TSH levels. This suggests that as metabolic dysfunctions in MetS worsen, thyroid dysfunction, particularly elevated TSH indicative of hypothyroidism, also increases.

Thyroid function tests further illustrated considerable variations between the MetS and control groups, with the former showing lower T3 levels and higher TSH levels, reinforcing the link between MetS and thyroid dysfunction. These findings suggest that metabolic syndrome may predispose individuals to subclinical hypothyroidism.

The study emphasises the significance of routine thyroid function monitoring in patients with metabolic syndrome by highlighting a greater frequency of subclinical hypothyroidism in this population. In individuals with Metabolic Syndrome, early identification and treatment of thyroid dysfunction may enhance clinical results and lower the chance of developing new metabolic problems. In order to successfully manage both illnesses, future research should examine the underlying processes of this connection as well as possible therapeutic strategies.

Recent research has examined the connection between MetS and subclinical hypothyroidism (SCH), as well as the risk factors that are linked to both disorders. These results emphasise how critical it is to comprehend how thyroid function and metabolic health interact. According to a population-based cohort study, young men's development of MetS was significantly correlated with SCH, but not with older people or women. Compared to males who were euthyroid, men with SCH had an adjusted hazard ratio of 1.87 for having MetS [7].

While SCH was not directly linked to MetS, one teenage investigation indicated that it was related with an increased risk of abdominal obesity and elevated blood pressure. This implies that adolescents with SCH may experience early metabolic changes [8]. A revised meta-analysis revealed a substantial correlation between SCH and a higher risk of metabolic syndrome (MetS) and its related conditions, including low HDL cholesterol, obesity, hypertension, and high triglycerides. In patients with SCH, the pooled odds ratio for MetS was 1.28 [9].

According to a study in a South Indian cohort, girls were more likely than males to have a 42.6% prevalence of MetS among SCH patients. Low HDL cholesterol and

abdominal obesity were the most prevalent MetS components [10]. A cross-sectional investigation discovered a substantial correlation between SCH and MetS, namely with increased triglycerides, central obesity, and waist circumference. The study underlined how crucial it is to keep an eye on thyroid function in people with MetS [11].

According to a hospital-based study, individuals with SCH had a considerably greater prevalence of MetS (44%) than did controls without SCH (25.6%). Important MetS elements in SCH patients were lipids, blood pressure, FBG, and waist circumference, all of which were significantly impacted [12]. According to a study, women with SCH exhibited considerably greater levels of non-HDL cholesterol, triglycerides, and cholesterol than participants with normal thyroid function. In addition, SCH women had a greater prevalence of MetS (29.4%) than did euthyroid women (18.7%) [13].

Conclusion

The study demonstrates a higher incidence of subclinical hypothyroidism in patients with metabolic syndrome compared to healthy controls. This underscores the importance of routine thyroid function screening in patients with MetS to facilitate early diagnosis and treatment of thyroid dysfunction.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: When treating patients with metabolic syndrome, healthcare professionals should think about doing routine thyroid function tests. To manage thyroid dysfunction in patients with metabolic syndrome (MetS), further research is required to investigate the underlying mechanisms and create tailored therapies.

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List of abbreviations:

MetS - Metabolic Syndrome

T2DM - Type 2 Diabetes Mellitus

SCH - Subclinical Hypothyroidism

TSH - Thyroid-Stimulating Hormone

T4 - Thyroxine

T3 - Triiodothyronine

FBG - Fasting Blood Glucose

HDL - High-Density Lipoprotein

BP - Blood Pressure

NCEP ATP III - National Cholesterol Education Program Adult Treatment Panel III

SD - Standard Deviation

μ IU/mL - Micro International Units per Milliliter

ng/dL - Nanograms per Deciliter

μ g/dL - Micrograms per Deciliter

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