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Prevalence and pattern of thyroid dysfunction among adults with metabolic syndrome: A cross-sectional observational study.

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Abstract

Background
Metabolic syndrome is linked with endocrine disturbances, including thyroid dysfunction, which may influence metabolic control and cardiovascular risk. This study assessed the prevalence and pattern of thyroid dysfunction among patients with metabolic syndrome.

Methods
A cross-sectional observational study was conducted in 100 adults who met the diagnostic criteria for metabolic syndrome. Thyroid function was evaluated using serum TSH, FT3, and FT4 levels. Thyroid status was classified as euthyroid, subclinical hypothyroidism, overt hypothyroidism, subclinical hyperthyroidism, or overt hyperthyroidism. Clinical details, metabolic parameters, and the number of metabolic syndrome components present were recorded. Data were analyzed, and results were presented using descriptive statistics.

Results
Thyroid dysfunction was observed in 36% of the study population. The most common abnormality was subclinical hypothyroidism (22%), followed by overt hypothyroidism (8%). Hyperthyroid patterns were less frequent (subclinical hyperthyroidism 4%, overt hyperthyroidism 2%). Females showed a significantly higher prevalence of dysfunction (57.1%) compared to males (20.7%). The age group of 40–59 years demonstrated the highest proportion of thyroid abnormalities (40.4%). A rising trend of thyroid dysfunction was noted with increasing metabolic load: 25.5% in those with three metabolic components, 45.7% with four components, and 60.0% with five components. These findings indicate a close association between metabolic burden and thyroid imbalance, as reflected by a significant positive correlation between BMI and TSH levels ($r = 0.42$, $p < 0.001$) and a significant inverse correlation between waist–hip ratio and serum T3 levels ($r = -0.36$, $p = 0.002$)

Conclusion
Thyroid dysfunction, particularly subclinical hypothyroidism, is common among patients with metabolic syndrome and is associated with female sex, middle age, and greater clustering of metabolic components.

Recommendations
Routine screening of thyroid function should be considered in patients with metabolic syndrome. Clinicians should maintain a proactive approach in counseling, early follow-up, and lifestyle modification to minimize disease progression.

Keywords: *Metabolic syndrome; Thyroid dysfunction; Subclinical hypothyroidism; Cardiometabolic risk; Endocrine profile*
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Introduction

Metabolic syndrome represents a cluster of interrelated metabolic abnormalities, including central obesity, dyslipidemia, hypertension, and impaired glucose regulation, and is recognized as a major global health

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concern due to its strong association with type 2 diabetes and cardiovascular disease [1]. The underlying pathophysiology is complex, involving insulin resistance, chronic low-grade inflammation, and altered hormonal signaling pathways that disrupt metabolic homeostasis [2]. Thyroid hormones play a key regulatory role in energy expenditure, lipid turnover, and glucose metabolism; therefore, even mild alterations in thyroid function can influence serum lipid levels, vascular tone, and insulin sensitivity [3].

Thyroid dysfunction and metabolic syndrome frequently coexist. Subclinical hypothyroidism has been particularly linked with elevated triglycerides, reduced high-density lipoprotein cholesterol, and increased body mass index, which are defining features of metabolic syndrome [1,4]. Additionally, insulin resistance may impair peripheral conversion of thyroxine (T4) to triiodothyronine (T3), further aggravating metabolic imbalance and fostering a state of functional hypothyroidism [5]. This bidirectional relationship suggests that thyroid dysfunction may worsen metabolic derangements, while the metabolic abnormalities inherent to metabolic syndrome may predispose individuals to thyroid hormone disturbances.

Understanding the prevalence and pattern of thyroid dysfunction in individuals with metabolic syndrome is clinically important. Unrecognized or untreated thyroid abnormalities can intensify dyslipidemia, promote atherosclerosis, and accelerate cardiovascular complications [4]. Early detection provides an opportunity for targeted intervention, including thyroid hormone normalization and structured lifestyle modification. However, reported prevalence rates vary across regions and populations, influenced by dietary iodine intake, genetic predisposition, and demographic variation [6]. This variability underscores the need for regional data to better guide clinical screening and management strategies.

In this context, the present study was undertaken to determine the prevalence and pattern of thyroid dysfunction among patients with metabolic syndrome. The study also aims to explore how thyroid abnormalities relate to demographic characteristics and the severity of metabolic clustering, thereby offering insights that may help guide patient evaluation and individualized care planning.

Methodology

Study design and setting

This was an observational cross-sectional study conducted in the Department of General Medicine, Government Medical College (GMC), Qutubullapur, Medchal–Malkajgiri, Telangana. The study duration was twelve months, from July 2024 to June 2025.

Participants

Participants were selected using non-probability consecutive sampling. All adult patients attending the outpatient or inpatient services who fulfilled the diagnostic criteria for metabolic syndrome during the study period were screened. Eligible patients who consented were enrolled until the required sample size was achieved. Patients with known thyroid disease, those on thyroid-altering medications, pregnancy, and acute systemic illness were excluded.

Study size

The sample size of 100 adult patients was chosen based on feasibility, study duration, and outpatient attendance during the study period. This size was considered adequate to estimate the prevalence and pattern of thyroid dysfunction in metabolic syndrome and to allow meaningful descriptive and correlation analysis.

Diagnostic criteria for metabolic syndrome

Metabolic syndrome was identified according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria. Patients were considered to have metabolic syndrome if they met at least three of the following conditions:

Waist circumference ≥90 cm in men and ≥80 cm in women

Fasting plasma glucose ≥100 mg/dL

Serum triglycerides ≥150 mg/dL

HDL cholesterol <40 mg/dL in men and <50 mg/dL in women

Blood pressure ≥130/85 mmHg or those already on antihypertensive treatment

Inclusion criteria

- Individuals aged 18 years and above
- Patients satisfying the NCEP ATP III criteria for metabolic syndrome

Exclusion criteria

- Patients with previously diagnosed and treated thyroid disorders
- Pregnant women
- Those with chronic renal or hepatic failure

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- Patients receiving drugs known to alter thyroid function (e.g., amiodarone, lithium, systemic corticosteroids)
- Critically ill or hospitalized patients requiring intensive care

Data collection

A structured proforma was used to document demographic profile, body measurements, blood pressure, and relevant medical history.

Laboratory investigations

Fasting venous blood samples were collected to estimate fasting plasma glucose, lipid profile, thyroid-stimulating hormone (TSH), free thyroxine (FT4), and free triiodothyronine (FT3). Thyroid function was categorized as follows:
Euthyroid: Normal TSH and FT4
Subclinical Hypothyroidism: Elevated TSH with normal FT4
Overt Hypothyroidism: Elevated TSH with decreased FT4
Subclinical Hyperthyroidism: Low TSH with normal FT4
Overt Hyperthyroidism: Low TSH with elevated FT4

Bias

Selection bias was minimized by enrolling consecutive eligible patients. Measurement bias was reduced by using standardized laboratory assays for thyroid function and uniform diagnostic criteria for metabolic syndrome. Data collection followed a predefined protocol to limit observer and information bias.

Statistical analysis

Data were entered and analyzed using descriptive statistics. Categorical variables were expressed as frequencies and percentages. The findings were presented using appropriate tables for comparison.

Ethical considerations

The study was approved by the Institutional Ethics Committee of Government Medical College, Qutubullapur. Written informed consent was obtained from every participant. Participant confidentiality and anonymity were maintained throughout the study.

Results

Participant flow

A total of 128 adults with suspected metabolic syndrome were screened during the study period. Of these, 112 were examined for eligibility. Twelve patients were excluded (known thyroid disease = 5, thyroid-altering medications = 4, pregnancy = 2, acute illness = 1). The remaining 100 participants met eligibility criteria, consented, and were included in the study. All enrolled participants completed clinical and laboratory evaluations and were included in the final analysis.

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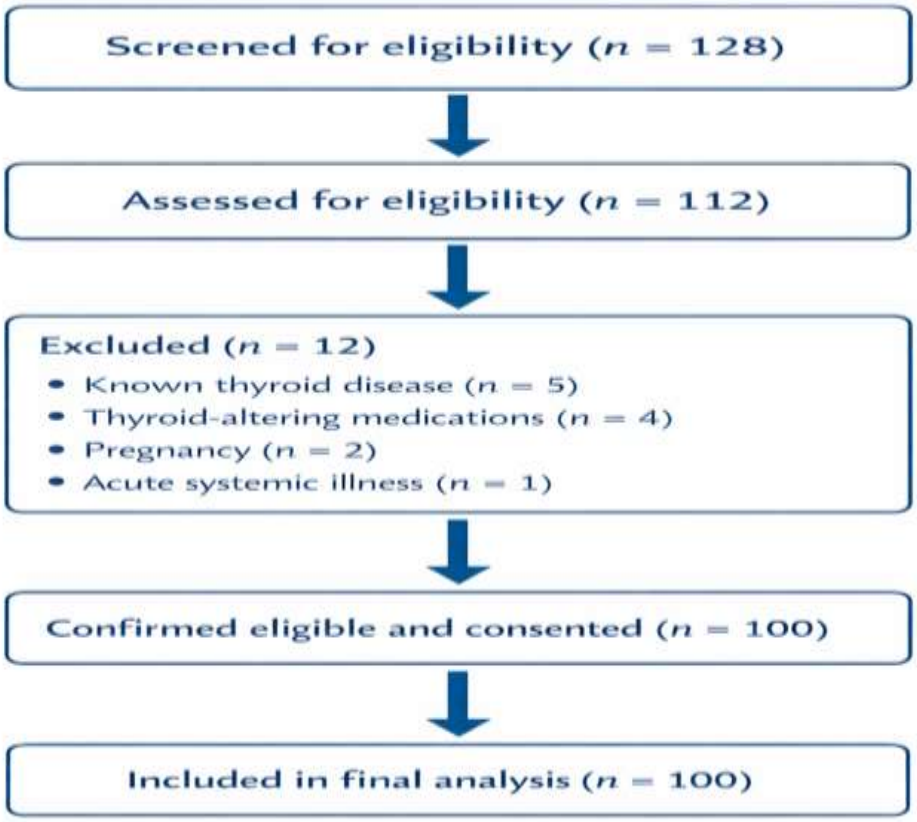

Figure 1: Participant flow diagram

Table 1. Socio-demographic and baseline clinical characteristics of participants (N = 100)

Variable	Value
Age (years)	
Mean ± SD	52.4 ± 8.9
30–39 years	18 (18.0%)
40–49 years	32 (32.0%)
50–59 years	38 (38.0%)
≥60 years	12 (12.0%)
Sex	
Male	58 (58.0%)
Female	42 (42.0%)
Body mass index (kg/m²)	28.6 ± 3.9
Waist circumference (cm)	
Male	102.4 ± 8.6
Female	96.8 ± 7.9
Waist–hip ratio	0.94 ± 0.06
Blood pressure (mmHg)	
Systolic BP	142.6 ± 14.2
Diastolic BP	90.8 ± 9.6
Duration of metabolic syndrome (years)	
<5 years	46 (46.0%)
≥5 years	54 (54.0%)
Associated comorbidities	
Type 2 diabetes mellitus	68 (68.0%)

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Hypertension	74 (74.0%)
Dyslipidaemia	61 (61.0%)

Table 1 summarizes the socio-demographic profile and baseline clinical characteristics of the study participants. The cohort consisted predominantly of middle-aged adults with a slight male preponderance. Most participants exhibited increased body mass index, central obesity, and elevated blood pressure levels consistent with metabolic syndrome. A substantial proportion had long-standing metabolic abnormalities and associated comorbidities, providing the clinical context for evaluating thyroid dysfunction in this population.

A total of 100 patients diagnosed with metabolic syndrome were enrolled in the present study. The distribution of thyroid status is summarized in **Table 2**. A majority of participants were euthyroid (64%), while thyroid dysfunction was identified in 36% of the study population. Subclinical hypothyroidism constituted the predominant abnormality (22%), followed by overt hypothyroidism (8%). Hyperthyroid states were less frequent, accounting for 6% collectively.

Table 2. Distribution of thyroid status among patients with metabolic syndrome (N = 100)

Thyroid Status	Frequency (n)	Percentage (%)
Euthyroid	64	64.0
Subclinical Hypothyroidism	22	22.0
Overt Hypothyroidism	8	8.0
Subclinical Hyperthyroidism	4	4.0
Overt Hyperthyroidism	2	2.0
Total Thyroid Dysfunction	**36**	**36.0**

Sex-wise comparison demonstrated a clear difference in the occurrence of thyroid dysfunction (**Table 3**). Females showed a considerably higher prevalence (57.1%) compared to males (20.7%). This pattern indicates a greater susceptibility among female patients with metabolic syndrome.

Table 3. Prevalence of thyroid dysfunction according to sex

Sex	Total (n)	Thyroid Dysfunction (n)	Prevalence (%)
Male	58	12	20.7
Female	42	24	57.1
Total	**100**	**36**	**36.0**

Age-related distribution is presented in **Table 4**. Thyroid dysfunction was more common among patients aged 40–59 years (40.4%), followed by those aged ≥60 years (36.7%). Participants younger than 40 years showed comparatively lower involvement (22.2%).

Table 4. Thyroid dysfunction distribution across age groups

Age Group (Years)	Total (n)	Dysfunction (n)	Percentage (%)
< 40	18	4	22.2
40 – 59	52	21	40.4
≥ 60	30	11	36.7
Total	**100**	**36**	**36.0**

An increasing trend of thyroid dysfunction was observed with a rise in the number of metabolic syndrome components present (**Table 5**). Patients exhibiting five metabolic components demonstrated the highest prevalence (60.0%), whereas those with three components had a lower prevalence (25.5%). This suggests that a higher metabolic burden is likely associated with worsening thyroid regulatory balance.

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Table 5. Thyroid dysfunction in relation to metabolic syndrome components

Number of MetS Components Present	Total (n)	Dysfunction (n)	Percentage (%)
3 Components	55	14	25.5
4 Components	35	16	45.7
5 Components	10	6	60.0
Total	**100**	**36**	**36.0**

Discussion

In this study, more than one-third of patients with metabolic syndrome showed thyroid dysfunction, with subclinical hypothyroidism being the most frequent pattern. This observation is consistent with growing evidence that even mild thyroid hormone disturbances can alter lipid turnover, energy balance, and vascular homeostasis, thereby contributing to the metabolic burden [7]. Thyroid hormones influence insulin sensitivity and adipocyte activity, meaning that subtle hormonal shifts may exacerbate central features of metabolic syndrome long before overt dysfunction becomes clinically evident [8].

The higher prevalence of thyroid dysfunction among females in this study was supported by a significantly greater proportion of affected females compared to males (57.1% vs. 20.7%), with female sex showing a strong association with thyroid dysfunction (χ^2 test, $p < 0.001$) aligns with the well-recognized predisposition of women to autoimmune and endocrine disorders, including thyroid disease [7]. Age also appeared to be an important factor, with individuals aged 40–59 years showing the greatest involvement. This stage of life is characterized by hormonal transitions, cumulative dietary influences, and changes in body composition, all of which may heighten susceptibility to metabolic–endocrine imbalance.

A noteworthy finding was the rise in thyroid dysfunction prevalence with an increasing number of metabolic syndrome components. This dose–response pattern suggests that systemic inflammation and oxidative stress may intensify with greater metabolic load, potentially affecting thyroid regulatory pathways [9]. Insulin resistance, a core feature of metabolic syndrome, has been shown to impair peripheral conversion of T4 to T3, contributing to a state resembling low-grade hypothyroidism [10,11].

Subclinical hypothyroidism is particularly relevant, as it is associated with elevated LDL cholesterol, increased adiposity, low-grade inflammation, and heightened cardiovascular risk [8,12]. Recognizing such patients early provides an opportunity to prevent long-term complications. Recent studies also show that even individuals with high-normal TSH values may exhibit adverse metabolic patterns, warranting careful clinical attention [12,13].

Overall, these findings underscore the importance of routine thyroid evaluation in patients with metabolic syndrome. Early identification, lifestyle modification, and optimized metabolic control may help stabilize thyroid status and reduce cardiovascular risk [14]. Larger multi-center longitudinal studies are required to confirm causality and refine management strategies.

Generalizability

The findings reflect patients attending a single tertiary care center and may not fully represent the broader community or rural populations. Diagnostic practices, lifestyle patterns, and genetic variations can differ across regions. Therefore, while the results provide useful insight, wider multi-center studies are needed to enhance external applicability and generalizability.

Conclusion

In conclusion, thyroid dysfunction was prevalent in more than one-third (36%) of patients with metabolic syndrome, indicating a substantial burden of thyroid abnormalities in this population. Subclinical hypothyroidism was the most frequent pattern observed. This study shows that thyroid dysfunction is relatively common among individuals with metabolic syndrome, with subclinical hypothyroidism being the predominant abnormality. The association was more evident in females, middle-aged adults, and in those presenting with a greater clustering of metabolic components, suggesting a close interaction between metabolic imbalance and thyroid regulation. Identifying thyroid dysfunction in the early phase is clinically valuable because it may worsen lipid parameters, promote weight gain, and heighten cardiovascular risk if left unaddressed. Routine thyroid function screening in patients with metabolic syndrome can support timely diagnosis and targeted management. Integrating lifestyle modification, metabolic control, and appropriate hormonal evaluation may improve long-term health outcomes in this population.

Limitations

This study was conducted at a single tertiary care center with a relatively small sample size, which may limit the

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wider applicability of the findings. Only cross-sectional data were collected, so causal relationships between metabolic syndrome and thyroid dysfunction cannot be established. Potential confounding factors such as dietary habits, physical activity, iodine intake, and autoimmune markers were not assessed. Larger, multi-center longitudinal studies are recommended for stronger evidence.

Recommendations

Routine thyroid function screening should be included in the evaluation of all patients with metabolic syndrome, especially among females and individuals with multiple metabolic components. Early identification of subclinical thyroid dysfunction allows timely intervention, preventing further metabolic deterioration and reducing cardiovascular risk. Clinicians should emphasize lifestyle measures such as weight control, a balanced diet, and regular physical activity, which may benefit both metabolic and thyroid health. Periodic monitoring of thyroid profiles is advised in high-risk patients. Further multi-center, longitudinal studies are recommended to strengthen the evidence base and explore the long-term clinical impact of managing thyroid dysfunction in metabolic syndrome.

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Abbreviations

MetS – Metabolic Syndrome
TSH – Thyroid-Stimulating Hormone
FT4 – Free Thyroxine
FT3 – Free Triiodothyronine
HDL – High-Density Lipoprotein
LDL – Low-Density Lipoprotein
BP – Blood Pressure
FPG – Fasting Plasma Glucose
NCEP ATP III – National Cholesterol Education Program Adult Treatment Panel III
BMI – Body Mass Index

Source of funding

The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

KMK-Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript. RK-design of the study, collected the results, review of literature, and prepared the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript.

Data availability

Data available on request

Author biography

Dr. Kannekanti Murali Krishna completed his MBBS from Kakatiya Medical College, Warangal (1990–1996). He later pursued an MD in General Medicine at Prathima Institute of Medical Sciences, Karimnagar (2015–2018). He has been actively engaged in clinical practice and medical education, with experience in managing a wide spectrum of internal medicine conditions. His academic interests include chronic disease management, cardiovascular medicine, and the training of medical students and residents. He is currently serving as an Associate Professor in the Department of General Medicine at Government Medical College, Siddipet.ORCID iD: https://orcid.org/0000-0002-3057-8271

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