

## ROLE OF ANTIOXIDANT AND INFLAMMATORY MARKERS WITH METABOLIC SYNDROME AND RISK OF CVD IN THYROID PATIENTS

RAVI SHANKAR<sup>1</sup>, AJAY KUMAR<sup>1</sup> NEHA SHARMA<sup>2\*</sup>, RAJU RAM<sup>3</sup>, APARAJITA KUSHWAHA<sup>4</sup>

<sup>1</sup>Department of Pacific Institute of Medical Sciences, Udaipur, Rajasthan, India. <sup>2</sup>Department of Shri Atal Bihari Vajpayee Government Medical College, Faridabad, Haryana, India. <sup>3</sup>Department of, M. K. Shah Medical College and Research Centre, Ahmadabad,

Gujarat, India. <sup>4</sup>Department of Pacific Medical College and Hospital, Udaipur, Rajasthan, India.

\*Corresponding author: Neha Sharma; Email: neha16.sharma@gmail.com

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### ABSTRACT

**Objectives:** Metabolic syndrome is the most widely used term for the aggregation of metabolic abnormalities, which leads to an increase in the risk of developing cardiovascular pathology. Protective nutritional antioxidants may benefit defensive antioxidative systems in resolving pro-oxidative dominance and redox imbalance, preventing, or delaying chronic thyroid diseases.

**Methods:** This cross-sectional, observational study was conducted among metabolic syndrome patients in the general population and near and dear patients (350) at the Pacific Institute of Medical Sciences, Udaipur. For the determination of interleukin-6 (IL-6) was done by enzyme-linked immunosorbent assay. Thyroid hormones are determined by chemiluminescence and antioxidant Vitamin C and malondialdehyde (MDA) chromatography and high-performance liquid chromatography, respectively.

**Results:** This study shows a low level of antioxidant Vitamin C and MDA and a high level of inflammatory marker IL-6 in these patients. In this study, the age distribution of patients showed that males in the 35–51 years of age group were most affected, whereas females in the 18–34 years of age group were more prevalent.

**Conclusion:** The present study leads to awareness of antioxidant levels and inflammation in thyroid patients along with other biochemical parameters involved in the development of metabolic syndrome in the Indian population.

**Keywords:** Malondialdehyde, Vitamin C, Thyroid, Metabolic syndrome, Inflammation.

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### INTRODUCTION

The metabolic abnormalities that condense into metabolic syndrome include insulin resistance, glucose intolerance, central obesity, dyslipidemia, and increased blood pressure, all of which are well-documented risk factors for cardiovascular mortality [1]. There has been a striking increase in the incidence of metabolic syndrome in the past two decades. This increase can be amounted to the global epidemic of diabetes and obesity. Projections of prevalence assume that the cases will rise up to 35.7 million people in the coming 20 years. Furthermore, it is also a major concern that about 57% of people still remain undiagnosed [3].

An imbalance between oxidants and antioxidants is observed at different stages and in different types of thyroid diseases. The organ, which is part of the endocrine system, uses free radicals reactive oxygen species (ROS) to produce hormones. Thyroid cells release enzymes that catalyze ROS generation; therefore, a key role is played by the internal defense system and non-enzymatic antioxidants that counteract excess ROS not utilized to produce thyroid hormones, acting as a buffer to neutralize free radicals and ensure whole-body homeostasis. An excess of free radicals causes structural cell damage, undermining genomic stability [4]. The risk of developing metabolic syndrome increases with age, about 19.5% of cases of metabolic syndrome were found to be aged between 20 and 39 years as opposed to 48.6% of people aged 60 years or older [5].

Metabolic syndrome constitutes a cluster of risk factors characterized by hypertension, atherogenic dyslipidemia, hyperglycemia, prothrombotic, and proinflammatory conditions [6]. This cluster

of metabolic abnormalities is associated with an increased risk for atherosclerotic cardiovascular disease (CVD) and type 2 diabetes mellitus [7]. The prevalence of metabolic syndrome is increasing worldwide with distinct evidence of high prevalence in India and other South Asian countries [8]. Various studies have shown that 30% of the Indian population suffers from metabolic syndrome and it was also found that this disease is more prevalent in Indian females (36%) as compared to Indian men (22%) [9]. Thyroid panel, malondialdehyde (MDA), Vitamin C, inflammatory markers, and lipoproteins are analyzed quantitatively to establish a possible correlation between metabolic syndrome, thyroid dysfunction, and the development of CVD in patients suffering from metabolic syndrome [8].

Both metabolic syndrome and hypothyroidism are considered to be independent risk factors for the development of CVD. This study aims to analyze the association of metabolic syndrome with thyroid dysfunction and the level of antioxidant and interleukin (IL-6) for assessing the impact of these diseases on the development of CVDs.

### METHODS

This cross-sectional, observational study was conducted among metabolic syndrome patients in the general population and near and dear patients at the Pacific Institute of Medical Sciences, Udaipur, after obtaining ethical clearance. Three hundred and fifty metabolic syndrome and thyroid disorder patients aged 18–65 years were selected during the study. The sample size was calculated by taking the prevalence of thyroid dysfunction as 28.2% (approximate) in this region [10]. Metabolic syndrome was diagnosed based on the modified Asian National Cholesterol Education Program Adult Treatment

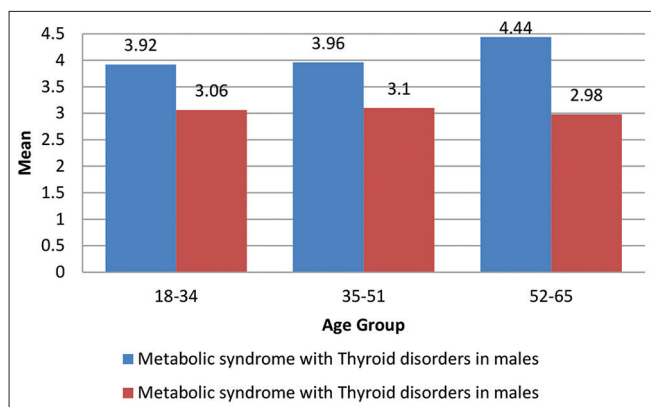


Fig. 1: Correlation of thyroid-stimulating hormone and Vitamin C in metabolic syndrome with thyroid disorders in males

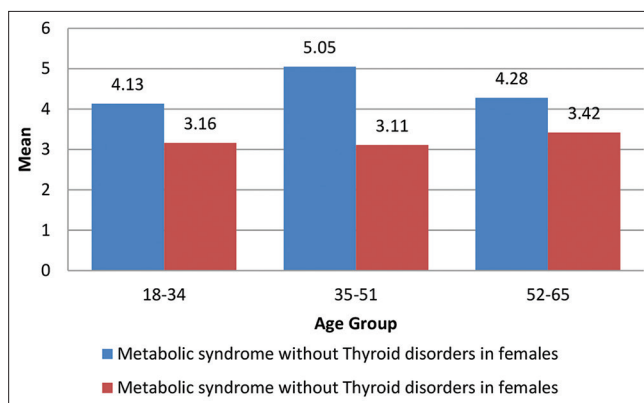


Fig. 4: Correlation of thyroid-stimulating hormone and Vitamin C in metabolic syndrome without thyroid disorders in females

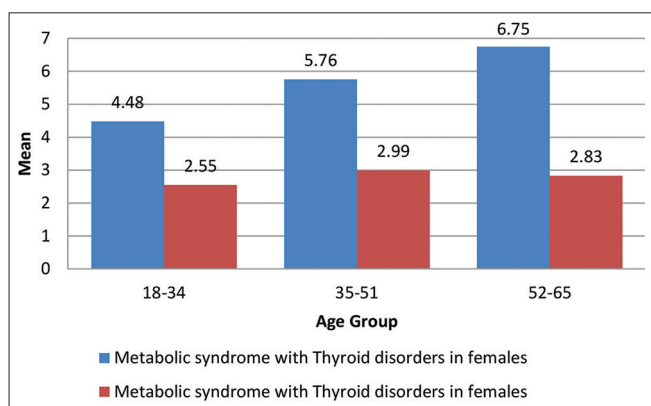


Fig. 2: Correlation of thyroid-stimulating hormone and Vitamin C in metabolic syndrome with thyroid disorders in females

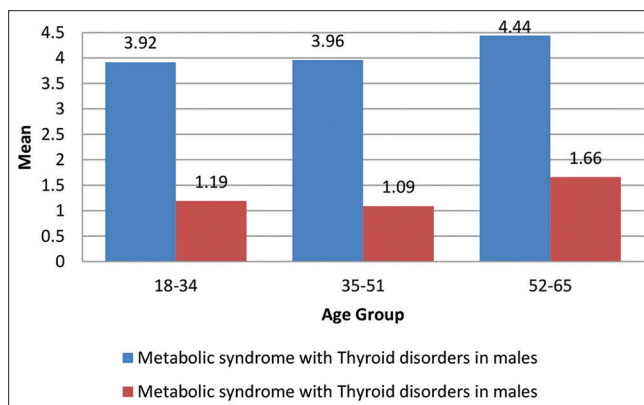


Fig. 5: Correlation of thyroid-stimulating hormone and malondialdehyde in metabolic syndrome with thyroid disorders in males

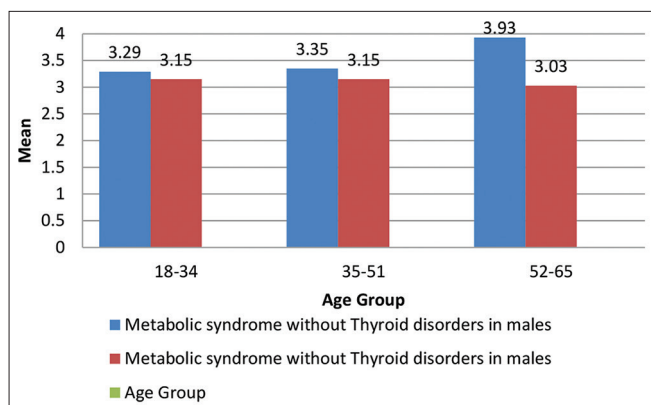


Fig. 3: Correlation of thyroid-stimulating hormone and Vitamin C in metabolic syndrome without thyroid disorders in males

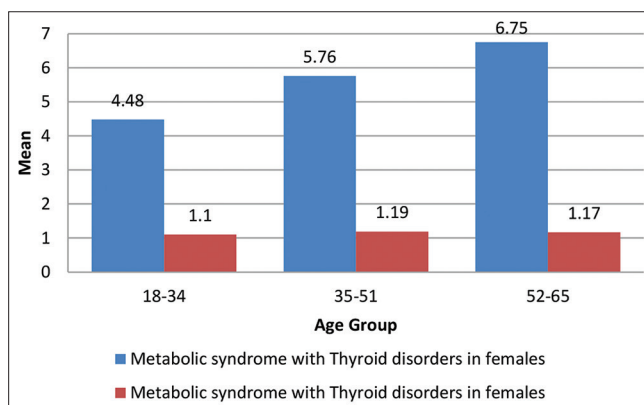


Fig. 6: Correlation of thyroid-stimulating hormone and malondialdehyde in metabolic syndrome with thyroid disorders in females

III panel criteria [11]. The study population comprised a total of 350 patients divided into six groups.

1. Metabolic syndrome patients with CVD
2. Metabolic syndrome patient without CVD
3. Thyroid disorder patients with CVD
4. Thyroid disorders patients without CVD
5. Patients with metabolic syndrome and thyroid disorders with CVD
6. Patients with metabolic syndrome and thyroid disorders without CVD.

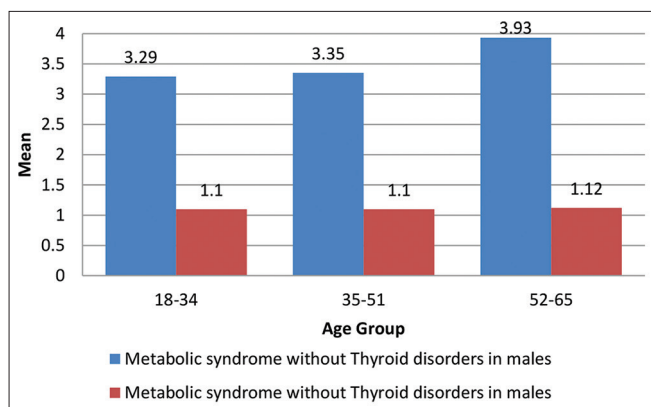
**Inclusion criteria**

Patients between 18 and 65 years of age who are suffering from metabolic syndrome and thyroid disorders with and without CVD.

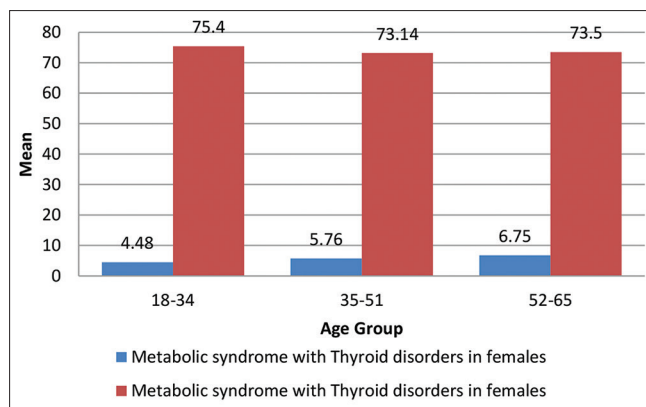
Exclusion criteria Patients receiving medication may alter thyroid functions, patients <18 and >65 years, pregnant women, patients using corticosteroids, patients suffering from active liver disease, patients suffering from kidney disease, patients who are suffering from diabetes mellitus, and diagnosed cancer patients were excluded from this study. Patients having any other systemic illness, diagnosed hypertensive patients were excluded in this study.

**Collection and sample analysis**

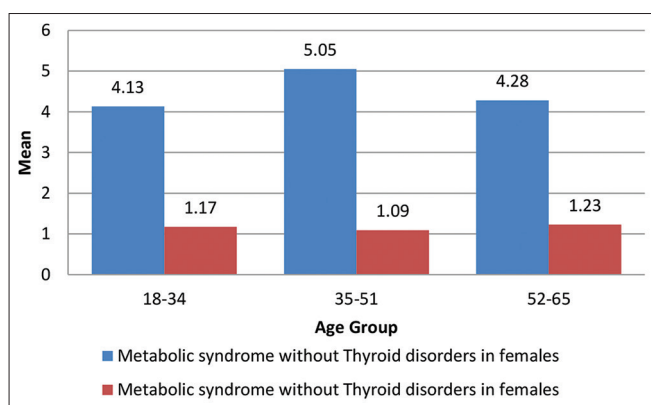
After taking the informed consent form for each patient, height, weight, waist circumference, and blood pressure will be taken from each



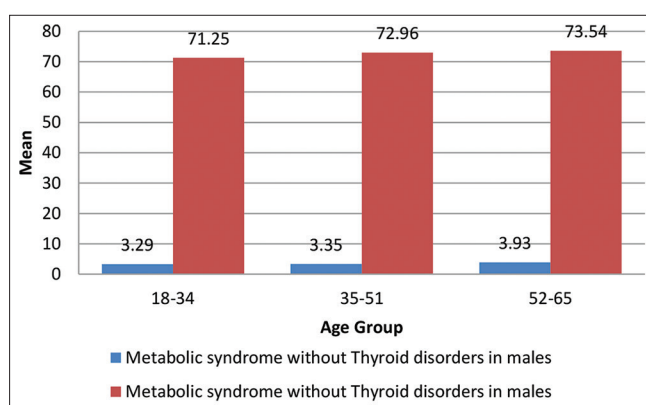
**Fig. 7: Correlation of thyroid-stimulating hormone and malondialdehyde in metabolic syndrome without thyroid disorders in males**



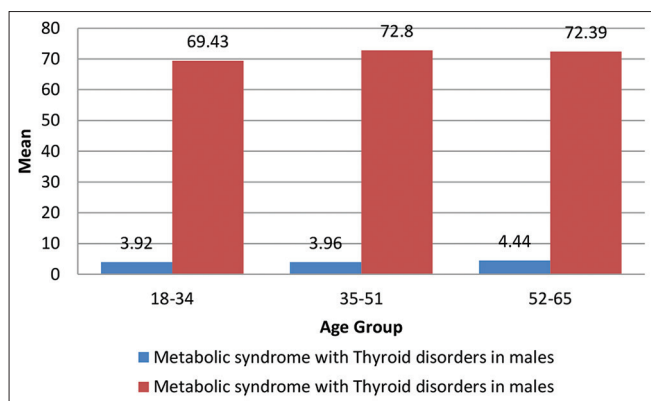
**Fig. 10: Correlation of thyroid-stimulating hormone and interleukin-6 in metabolic syndrome with thyroid disorders in females**



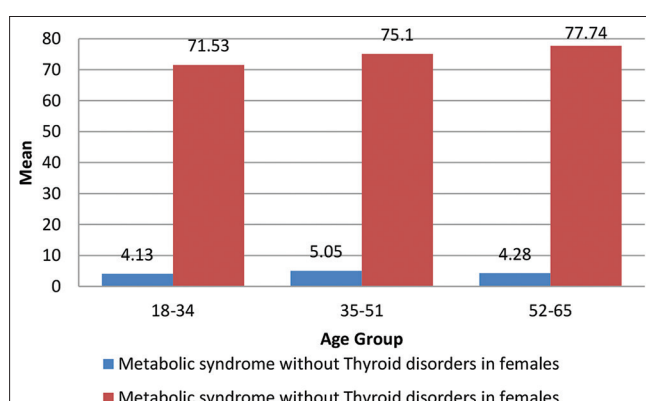
**Fig. 8: Correlation of thyroid-stimulating hormone and malondialdehyde in metabolic syndrome without thyroid disorders in females**



**Fig. 11: Correlation of thyroid-stimulating hormone and interleukin-6 in metabolic syndrome without thyroid disorders in males**



**Fig. 9: Correlation of thyroid-stimulating hormone and interleukin-6 in metabolic syndrome with thyroid disorders in males**



**Fig. 12: Correlation of thyroid-stimulating hormone and interleukin-6 in metabolic syndrome without thyroid disorders in females**

subject. For the determination of IL-6 was done by enzyme-linked immunosorbent assay (ELISA) [9-11]. Thyroid hormones determined by chemiluminescence and Vitamin C and antioxidant levels were analyzed by chromatography and high-performance liquid chromatography [12]. 5 mL fasting sample will be collected by vein puncture in a vacutainer and centrifuged at 3000 rpm for 15 min for serum separation.

**Statistical analysis**

The data were collected and entered into Microsoft Excel sheet in the form of a master chart and were analyzed using standard statistical software (SPSS version 20) and other supporting online software.

**RESULTS**

In this study, the age distribution of patients showed that males in the 35-51 years of age group were most affected, while females in the 18-34 years of age group were more prevalent. This highlights the importance of age in the development of metabolic syndrome and associated comorbidities. The study analyzed inflammatory markers such as IL-6 levels in females and males with metabolic syndrome and CVD. The results showed no significant differences among age groups for both inflammatory markers, indicating that age does not

significantly influence systemic inflammation in females or males with metabolic syndrome and CVD.

## DISCUSSION

The present study showed that metabolic syndrome with thyroid disorders and CVD may be associated with increased oxidative stress, particularly in older age groups. It was done in the Udaipur region of Rajasthan state. Table 1 metabolic syndrome with thyroid disorders in males, for males with metabolic syndrome and thyroid disorders, thyroid-stimulating hormone (TSH) and Vitamin C levels are recorded. For ages 18–34, TSH is  $3.92 \pm 2.34$  and Vitamin C is  $3.06 \pm 0.54$ . For the 35–51 years of age groups, TSH is  $3.96 \pm 2.17$  and Vitamin C is  $3.10 \pm 0.54$ . In the 52–65 years of age groups, TSH is  $4.44 \pm 2.52$  and Vitamin C is  $2.98 \pm 0.63$ . TSH levels increase slightly with age, whereas Vitamin C levels decrease slightly [8]. Table 2 shows metabolic syndrome with thyroid disorders in females, for females with metabolic syndrome and thyroid disorders, TSH and Vitamin C levels are recorded. For ages 18–34, TSH is  $4.48 \pm 2.03$  and Vitamin C is  $2.55 \pm 0.39$ . For the 35–51 age groups, TSH is  $5.76 \pm 3.25$  and Vitamin C is  $2.99 \pm 0.55$ . In the 52–65 age groups, TSH is  $6.75 \pm 3.61$  and Vitamin C is  $2.83 \pm 0.59$ . Both TSH levels and Vitamin C levels increase slightly with age [11]. Table 3 metabolic syndrome without thyroid disorders in males, males with metabolic syndrome but without thyroid disorders have the following levels. For ages 18–34, TSH is  $3.29 \pm 0.94$  and Vitamin C is  $3.15 \pm 0.65$ . For the 35–51 age groups, TSH is  $3.35 \pm 1.33$  and Vitamin C is  $3.15 \pm 0.47$ . In the 52–65 age groups, TSH is  $3.93 \pm 2.37$  and Vitamin C is  $3.03 \pm 0.70$ . Both TSH and Vitamin C levels show a slight decrease with age [25]. Table 4 metabolic syndrome without thyroid disorders in females. For females with metabolic syndrome but without thyroid disorders, TSH and Vitamin C levels are recorded. For ages 18–34, TSH is  $4.13 \pm 3.17$  and Vitamin C is  $3.16 \pm 0.50$ . For the 35–51 years of age groups, TSH is  $5.05 \pm 2.84$  and Vitamin C is  $3.11 \pm 0.75$ . In the 52–65 years of age groups,

**Table 1: Correlation of TSH and Vitamin C in metabolic syndrome with thyroid disorders in males**

Age group	Metabolic syndrome with thyroid disorders in males	
	TSH	Vitamin C
18–34	$3.92 \pm 2.34$	$3.06 \pm 0.54$
35–51	$3.96 \pm 2.17$	$3.10 \pm 0.54$
52–65	$4.44 \pm 2.52$	$2.98 \pm 0.63$

TSH: Thyroid-stimulating hormone

**Table 2: Correlation of TSH and Vitamin C in metabolic syndrome with thyroid disorders in females**

Age group	Metabolic syndrome with thyroid disorders in females	
	TSH	Vitamin C
18–34	$4.48 \pm 2.03$	$2.55 \pm 0.39$
35–51	$5.76 \pm 3.25$	$2.99 \pm 0.55$
52–65	$6.75 \pm 3.61$	$2.83 \pm 0.59$

TSH: Thyroid-stimulating hormone

**Table 3: Correlation of TSH and Vitamin C in metabolic syndrome without thyroid disorders in males**

Age group	Metabolic syndrome without thyroid disorders in males	
	TSH	Vitamin C
18–34	$3.29 \pm 0.94$	$3.15 \pm 0.65$
35–51	$3.35 \pm 1.33$	$3.15 \pm 0.47$
52–65	$3.93 \pm 2.37$	$3.03 \pm 0.70$

TSH: Thyroid-stimulating hormone

TSH is  $4.28 \pm 2.63$  and Vitamin C is  $3.42 \pm 0.92$ . Both TSH and Vitamin C levels show an increasing trend with age [13]. Table 5 shows metabolic syndrome with thyroid disorders in males. For males with metabolic syndrome and thyroid disorders, TSH and MDA levels are recorded. For ages 18–34, TSH is  $3.92 \pm 2.34$  and MDA is  $1.19 \pm 0.22$ . For the 35–51 age groups, TSH is  $3.96 \pm 2.17$  and MDA is  $1.09 \pm 0.26$ . In the 52–65 age groups, TSH is  $4.44 \pm 2.52$  and MDA is  $1.66 \pm 0.18$ . TSH levels increase with age, while MDA levels also show an increasing trend [13].

Table 6 shows metabolic syndrome with thyroid disorders in females. For females with metabolic syndrome and thyroid disorders, TSH and MDA levels are recorded. For ages 18–34, TSH is  $4.48 \pm 2.03$  and MDA is  $1.10 \pm 0.23$ . For the 35–51 age groups, TSH is  $5.76 \pm 3.25$  and MDA is  $1.19 \pm 0.28$ . In the 52–65 age groups, TSH is  $6.75 \pm 3.61$  and MDA is  $1.17 \pm 0.19$ . Both TSH and MDA levels show an increasing trend with age, indicating higher oxidative stress in older age groups [13]. Table 7 shows metabolic syndrome without thyroid disorders in males. Males with metabolic syndrome but without thyroid disorders have the following levels of TSH and MDA. For ages 18–34, TSH is  $3.29 \pm 0.94$  and MDA is  $1.10 \pm 0.18$ . For the 35–51 age groups, TSH is  $3.35 \pm 1.33$  and

**Table 4: Correlation of TSH and Vitamin C in metabolic syndrome without thyroid disorders in females**

Age group	Metabolic syndrome without thyroid disorders in females	
	TSH	Vitamin C
18–34	$4.13 \pm 3.17$	$3.16 \pm 0.50$
35–51	$5.05 \pm 2.84$	$3.11 \pm 0.75$
52–65	$4.28 \pm 2.63$	$3.42 \pm 0.92$

TSH: Thyroid-stimulating hormone

**Table 5: Correlation of TSH and MDA in metabolic syndrome with thyroid disorders in males**

Age group	Metabolic syndrome with thyroid disorders in males	
	TSH	MDA
18–34	$3.92 \pm 2.34$	$1.19 \pm 0.22$
35–51	$3.96 \pm 2.17$	$1.09 \pm 0.26$
52–65	$4.44 \pm 2.52$	$1.66 \pm 0.18$

TSH: Thyroid-stimulating hormone, MDA: Malondialdehyde

**Table 6: Correlation of TSH and MDA in metabolic syndrome with thyroid disorders in females**

Age group	Metabolic syndrome with thyroid disorders in females	
	TSH	MDA
18–34	$4.48 \pm 2.03$	$1.10 \pm 0.23$
35–51	$5.76 \pm 3.25$	$1.19 \pm 0.28$
52–65	$6.75 \pm 3.61$	$1.17 \pm 0.19$

TSH: Thyroid-stimulating hormone, MDA: Malondialdehyde

**Table 7: Correlation of TSH and MDA in metabolic syndrome without thyroid disorders in males**

Age group	Metabolic syndrome without thyroid disorders in males	
	TSH	MDA
18–34	$3.29 \pm 0.94$	$1.10 \pm 0.18$
35–51	$3.35 \pm 1.33$	$1.10 \pm 0.22$
52–65	$3.93 \pm 2.37$	$1.12 \pm 0.24$

TSH: Thyroid-stimulating hormone, MDA: Malondialdehyde

**Table 8: Correlation of TSH and MDA in metabolic syndrome without thyroid disorders in females**

Age group	Metabolic syndrome without thyroid disorders in females	
	TSH	MDA
18-34	4.13±3.17	1.17±0.25
35-51	5.05±2.84	1.09±0.20
52-65	4.28±2.63	1.23±0.28

TSH: Thyroid-stimulating hormone, MDA: Malondialdehyde

**Table 9: Correlation of TSH and IL-6 in metabolic syndrome with thyroid disorders in males**

Age group	Metabolic syndrome with thyroid disorders in males	
	TSH	IL-6
18-34	3.92±2.34	69.43±8.29
35-51	3.96±2.17	72.80±6.50
52-65	4.44±2.52	72.39±6.16

TSH: Thyroid-stimulating hormone, IL-6: Interleukin-6

**Table 10: Correlation of TSH and IL-6 in metabolic syndrome with thyroid disorders in females**

Age group	Metabolic syndrome with thyroid disorders in females	
	TSH	IL-6
18-34	4.48±2.03	75.40±6.83
35-51	5.76±3.25	73.14±7.08
52-65	6.75±3.61	73.50±9.82

TSH: Thyroid-stimulating hormone, IL-6: Interleukin-6

MDA is 1.10±0.22. In the 52-65 age groups, TSH is 3.93±2.37 and MDA is 1.12±0.24. Both TSH and MDA levels remain relatively stable across different age groups [14]. Table 8 shows metabolic syndrome without thyroid disorders in females.

For females with metabolic syndrome but without thyroid disorders, TSH and MDA levels are recorded. For ages 18-34, TSH is 4.13±3.17 and MDA is 1.17±0.25. For the 35-51 age groups, TSH is 5.05±2.84 and MDA is 1.09±0.20. In the 52-65 years of age groups, TSH is 4.28±2.63 and MDA is 1.23±0.28. Both TSH and MDA levels show a slight increase with age, indicating a possible increase in oxidative stress [15]. Table 9 shows metabolic syndrome with thyroid disorders in males. For males with metabolic syndrome and thyroid disorders, TSH and IL-6 levels are recorded. For ages 18-34, TSH is 3.92±2.34 and IL-6 is 69.43±8.29. For the 35-51 age groups, TSH is 3.96±2.17 and IL-6 is 72.80±6.50. In the 52-65 age groups, TSH is 4.44±2.52 and IL-6 is 72.39±6.16. Both TSH and IL-6 levels show a slight increase with age, indicating a rise in inflammatory markers [16]. Table 10 shows metabolic syndrome with thyroid disorders in females.

For females with metabolic syndrome and thyroid disorders, TSH and IL-6 levels are recorded. For ages 18-34, TSH is 4.48±2.03 and IL-6 is 75.40±6.83. For the 35-51 age groups, TSH is 5.76±3.25 and IL-6 is 73.14±7.08. In the 52-65 age groups, TSH is 6.75±3.61 and IL-6 is 73.50±9.82. Both TSH and IL-6 levels show a trend of increasing with age, reflecting a higher inflammatory state in older females [10]. Table 11 shows metabolic syndrome without thyroid disorders in males. Males with metabolic syndrome but without thyroid disorders have the following levels of TSH and IL-6. For ages 18-34, TSH is 3.29±0.94 and IL-6 is 71.25±6.18 [17]. For the 35-51 age groups, TSH is 3.35±1.33 and IL-6 is 72.96±9.30. In the 52-65 age groups, TSH is 3.93±2.37 and IL-6 is 73.54±8.64. Both TSH and IL-6 levels show slight

**Table 11: Correlation of TSH and IL-6 in metabolic syndrome without thyroid disorders in males**

Age group	Metabolic syndrome without thyroid disorders in males	
	TSH	IL-6
18-34	3.29±0.94	71.25±6.18
35-51	3.35±1.33	72.96±9.30
52-65	3.93±2.37	73.54±8.64

TSH: Thyroid-stimulating hormone, IL-6: Interleukin-6

**Table 12: Correlation of TSH and IL-6 in metabolic syndrome without thyroid disorders in females**

Age group	Metabolic syndrome without thyroid disorders in females	
	TSH	IL-6
18-34	4.13±3.17	71.53±8.40
35-51	5.05±2.84	75.10±8.67
52-65	4.28±2.63	77.74±6.07

TSH: Thyroid-stimulating hormone, IL-6: Interleukin-6

increases with age, indicating a consistent inflammatory response across age groups.

Table 12 shows metabolic syndrome without thyroid disorders in females. For females with metabolic syndrome but without thyroid disorders, TSH and IL-6 levels are recorded. For ages 18-34, TSH is 4.13±3.17 and IL-6 is 71.53±8.40. For the 35-51 age groups, TSH is 5.05±2.84 and IL-6 is 75.10±8.67. In the 52-65 age groups, TSH is 4.28±2.63 and IL-6 is 77.74±6.07. Both TSH and IL-6 levels show an increasing trend with age, indicating higher inflammation in older females [18]. Further researches in this area have the potential to inform the development of targeted interventions and personalized strategies for preventing and managing metabolic and CVDs.

## CONCLUSION

The present study leads to awareness of antioxidant levels and inflammation in thyroid patients along with other biochemical parameters which involved in the development of metabolic syndrome in Indian population.

## CONFLICT OF INTEREST

None.

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