

Evaluation of the Multifaceted Impact of Hypothyroidism on Metabolic Components and Quality of Life

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ABSTRACT

Background: Hypothyroidism is characterized by an underactive thyroid gland. As thyroid hormones are essential for regulating metabolism, disruptions in secretions can cause metabolic syndrome. This study is to assess the relationship of hypothyroidism with metabolic components and quality of life. **Materials and Methods:** A cross-sectional study was conducted over a year in the department of general medicine of a tertiary care hospital with 200 patients diagnosed with hypothyroidism with metabolic syndrome. Metabolic syndrome was determined using modified NCEP ATP III criteria (2005 revision). The study parameters were Thyroid Hormones (TSH, T3 and T4), metabolic components and quality of life (assessed using the WHOQOL BREF questionnaire). Spearman's correlation analysis was used to determine the relationship between TSH and metabolic components. **Results:** Thyroid Stimulating Hormone (TSH) exhibited a significant positive correlation with BMI (R: 0.07, p: 0.02), systolic blood pressure (R: 0.18, p: 0.008), triglycerides (R: 0.15, p: 0.03) and fasting blood sugar (R: 0.13, p: 0.05) and a negative correlation with High-Density Lipoprotein (R: -0.14, p: 0.04). Regarding quality-of-life domains, TSH has a significant negative correlation with the physical domain (R: -0.18, p: 0.08). **Conclusion:** Hypothyroidism is associated with body mass index, waist circumference, blood pressure and triglycerides but has a negative relationship with high-density lipoprotein. Patients with hypothyroidism with metabolic syndrome experience a poor quality of life, especially in the physical domain.

Keywords: Hypothyroidism, Metabolic syndrome, Thyroid stimulating hormone, Quality of life.

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INTRODUCTION

Thyroid hormones play a crucial role in metabolism (Mullur *et al.*, 2014). Disruptions in their secretion can lead to Metabolic Syndrome (MetS), characterized by insulin resistance, hypertension, hyperglycemia and abnormal cholesterol levels (Fahed *et al.*, 2022).

In the Western world, Hypothyroidism (HT) affects about 5% of its population, with another 5% potentially undiagnosed (Chiovato *et al.*, 2019; Garmendia *et al.*, 2014). In India, HT is the most prevalent thyroid disorder, affecting 10.9% of adults (Unnikrishnan *et al.*, 2013; (Kumar *et al.*, 2022).

HT is related to MetS, including dyslipidemia, hypertension, obesity and insulin resistance (Shaji and Joel, 2022; Mavromati and Jornayvaz, 2021). Studies indicate that 95% of newly detected hypothyroid cases exhibit elevated cholesterol levels, with 5% presenting with hypertriglyceridemia (Glucic *et al.*, 2015).

HT can present with vague and nonspecific symptoms that often resemble those of other conditions, making diagnosis difficult. Weight gain results from decreased fat burning, while cold intolerance stems from reduced heat production. This affects the Quality of Life (QOL) (Chaker *et al.*, 2017).

The primary treatment for HT is levothyroxine, with dosage adjusted based on TSH levels and clinical symptoms (Razvi *et al.*, 2020). Special considerations are required for pregnant women, central hypothyroidism and those with alternative treatments such as liothyronine or supplements (Lee and Pearce, 2022; Jonklaas *et al.*, 2014). Regular monitoring and dosage adjustments are essential to prevent drug-related problems.



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Patients with HT experience poor QOL, particularly in the physical dimensions compared to social dimensions (Ghamr *et al.*, 2022). Physicians should regularly assess hypothyroid patients' QOL and prioritize improving it as part of their management plan (Shivaprasad *et al.*, 2018). With this background, the study assess the impact of hypothyroidism on metabolic components and QOL.

MATERIALS AND METHODS

Study design and setting

The study is part of a long-term study conducted in the Department of General Medicine of a tertiary care hospital, which analyses the impact of clinical pharmacy services in hypothyroid patients with MetS.

Sample size

The sample size determination was based on a 5% level of significance, 80% power, a mean difference of 1.3 and an effect size of 0.435. The required sample size was calculated as 200, using nMaster software, version 2.0.

Ethical Approval

The Central Ethics Committee, Nitte (Deemed to be University), approved the study (Ref. No: NU/CEC/2022/317), prior to initiation. The investigator explained the study to the participants and obtained their written informed consent. Participants who gave voluntary consent were enrolled in the study. Privacy and confidentiality were maintained throughout the study.

Participant Enrollment

Inclusion Criteria

The study included patients aged 18 years and above diagnosed with hypothyroidism with metabolic syndrome. MetS was determined using the modified NCEP ATP III criteria (2005 revision) (National Cholesterol Education Program (NCEP), 2002). Both Inpatients and Outpatients were included in the study.

Exclusion Criteria

Pediatric patients, Pregnant women, Patients who had undergone thyroid surgery, Type I Diabetic Mellitus, Psychiatric illness and Cancer patients were excluded from the study.

Based on the inclusion and exclusion criteria, eligible patients were enrolled randomly after obtaining written consent.

Laboratory TESTS

As part of their regular checkup, the patients gave their blood samples to the laboratory following the consultation with their physician. A qualified medical laboratory technician collects the blood sample and analyzes it for Thyroid function tests (TSH, T3, T4) and metabolic components (FBS, TG and HDL). A consultant

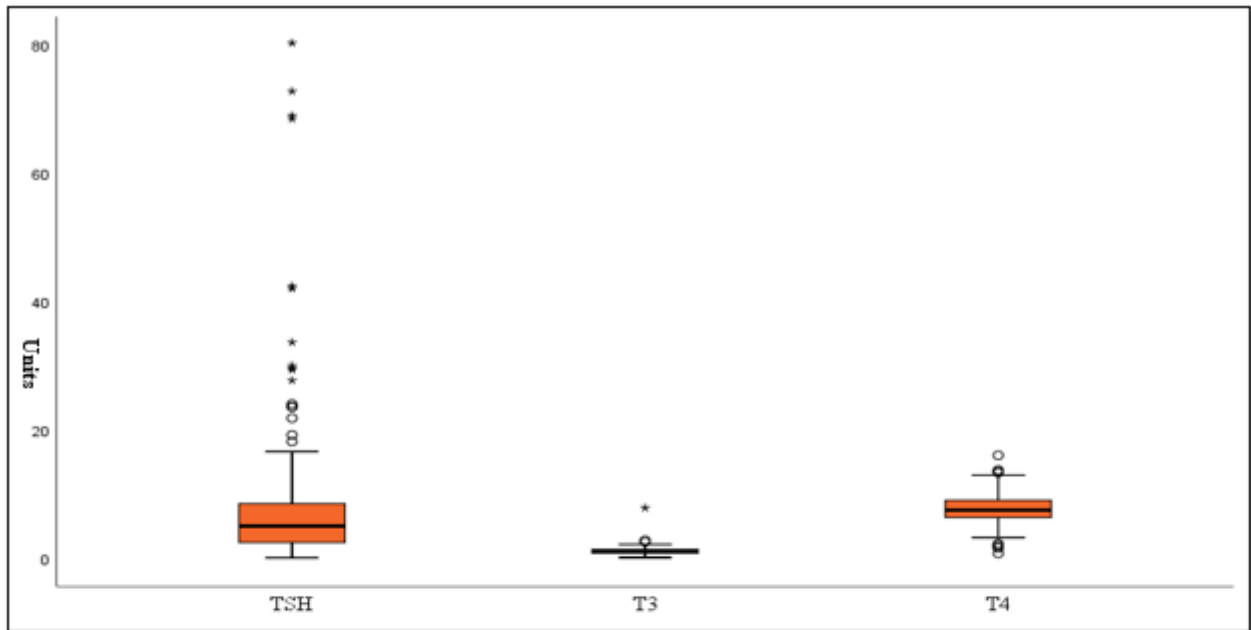
Table 1: Sociodemographics of the study population.

Characteristics	Frequency	Percentage (%)
Age Group		
Less than 40	20	10
40 - 50	62	31
51 - 60	63	31.5
61 - 70	55	27.5
Gender wise Distribution		
Male	48	24
Female	152	76
Body Mass Index		
Healthy (18.5-24.9)	59	29.5
Overweight (25.0-29.9)	121	60.5
Obese (30.0 and above)	20	10
Educational Status		
Primary School	117	58.5
Middle School	38	19
Secondary School	39	19.5
Graduate	6	3
Comorbid Conditions		
Diabetes Mellitus	47	23.5
Hypertension	43	21.5
Dyslipidemia	21	10.5
Diabetes Mellitus and Hypertension	51	25.5
Diabetes Mellitus and Dyslipidemia	14	7
Hypertension and Dyslipidemia	13	6.5
Hypertension, Diabetes Mellitus and Dyslipidemia	11	5.5
Socio-economic Status		
Upper Lower	66	33
Lower Middle	82	41
Upper Middle	52	26

pathologist verified the laboratory reports. The researcher collected the study subjects' laboratory data and documented it for data analysis.

Definition of MetS

As per Modified NCEP ATP III (2005 revision) MetS is determined as the presence of three or more of the following five



Metabolic Components and Quality of Life

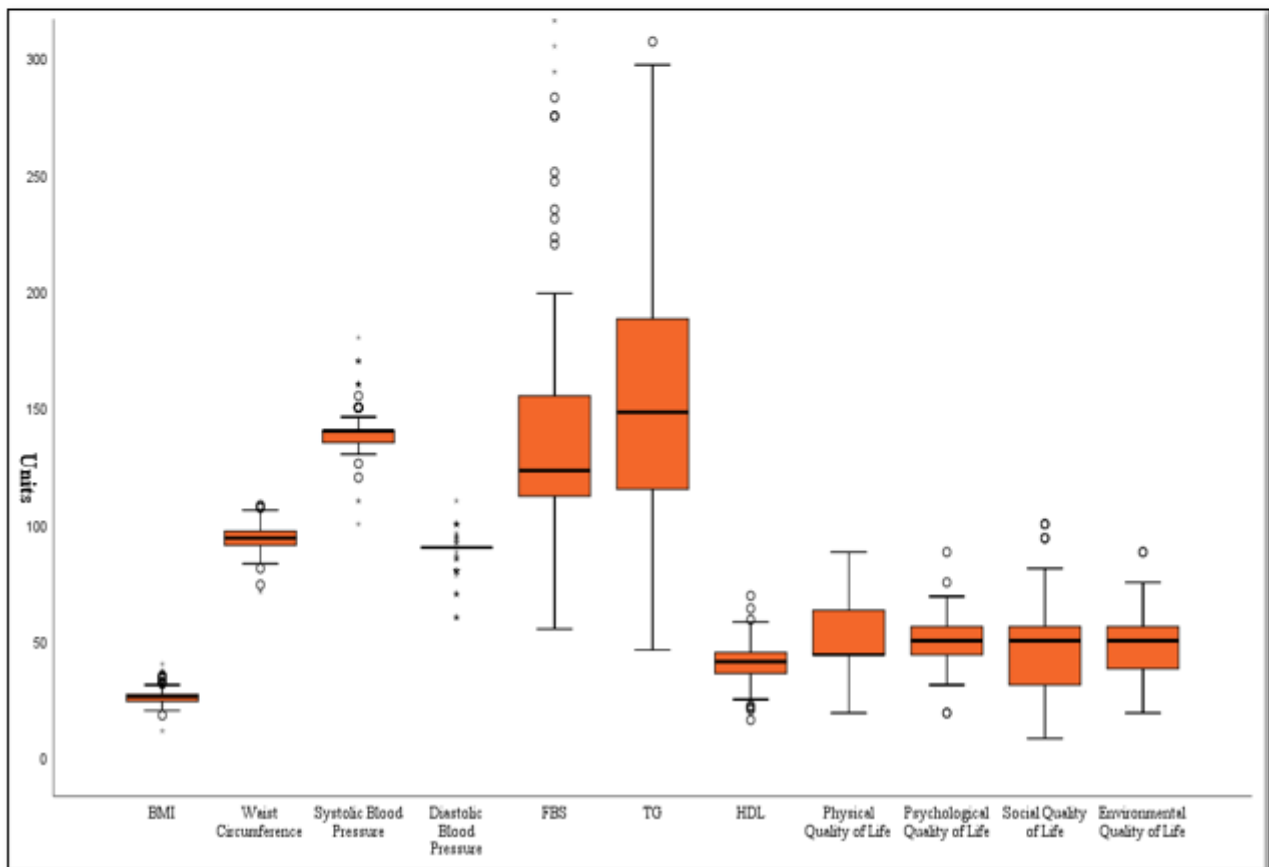


Figure 1: Levels of Thyroid Hormones, Metabolic Components and Quality of Life Metabolic Components and Quality of Life.

Table 2: Thyroid Hormones and Metabolic Components.

Thyroid Hormones	Mean	Standard Deviation
TSH	13.59	32.69
T3	1.65	6.88
T4	8.42	9.15
Metabolic Components		
BMI	25.75	3.36
Waist Circumference	94.32	5.22
Systolic Blood Pressure	139.70	10.53
Diastolic Blood Pressure	88.07	6.88
Fasting Blood Sugar	139.26	43.72
Triglycerides	159.20	57.04
Quality of Life		
Physical Domain	48.34	12.84
Psychological Domain	51.46	10.58
Social Domain	49.78	17.00
Environmental Domain	49.29	12.63

criteria: WC above 40 inches (men) or 35 inches (women), BP above 130/85 mmHg or on treatment, fasting TG above 150 mg/dL or on treatment, fasting HDL cholesterol levels less than 40 mg/dL (men) or 50 mg/dL (women) and FBS above 100 mg/dl or on treatment.

Blood Pressure, Waist Circumference and Body Mass Index Measurements

The BP, WC and BMI were assessed as a part of the regular checkup. The data were documented by the researcher for analysis.

Assessment of Quality of Life (QOL)

The QOL was assessed using the WHOQOL BREF, a short version of the WHOQOL questionnaire. The questionnaire was translated from English to regional languages (Kannada and Malayalam). The researchers requested the study participants to complete the WHOQOL BREF Questionnaire within 30 min and the responses were collected and documented. The scores were converted to the WHOQOL questionnaire format and analyzed.

Statistical Analysis

The collected data were documented using Microsoft Excel 2021 and statistically analyzed with SPSS version 29. The categorical variables were presented as frequency and percentage. Mean and standard deviation were used to illustrate the thyroid hormones,

metabolic components and quality of life. The relationship between TSH with Metabolic Components and QOL was analyzed using Spearman's Correlation. Multiple linear Regressions was used to analyze the effect of TSH on Metabolic Components and Quality of Life.

RESULTS

Sociodemographics of the Study Population

Among 200 study subjects, the majority of the patients were females. The mean age of the subjects were 51.93±10.09. The majority of the subjects (60.5%) were overweight. Based on the level of education, 58.5% had completed primary school, 19% middle school, 19.5% secondary school and 3% were graduates. Among the study subjects, Diabetes mellitus was present in 23.5% of the patients, hypertension in 21.5% and dyslipidemia in 10.5% of the patients. Moreover, 25.5% of patients have both diabetes mellitus and hypertension, 7% have diabetes mellitus and dyslipidemia, 6.5% have hypertension and dyslipidemia and 5.5% have all three disease conditions. Based on socioeconomic status, 33% of the patients were in the upper-lower class, 41% in the lower-middle class and 26% in the upper-middle class (Table 1).

Thyroid Hormones, Metabolic Components and Quality of Life (QOL)

In the study subjects, the mean TSH, T3 and T4 were 13.59±32.69, 1.65±6.88 and 8.42±9.15, respectively. Among the metabolic components, the mean BMI, WC, SBP and DBP, TG, HDL and FBS were 25.75±3.36 kg/m², 94.32±5.22 cm, 139.70±10.53 mmHg, 88.07±6.88 mmHg, 159.20±57.04 mg/dL, 40.83±8.1 mg/dL, 139.26±43.72 mg/dL respectively.

Across the four domains of physical, psychological, social and environmental QOL, the mean scores were 48.34±12.84, 51.46±10.58, 49.78±17.00 and 49.29±12.63, respectively (Table 2), (Figure 1).

Association between TSH and Metabolic Components

Association between TSH and BMI

A significant weak positive correlation (R: 0.070, p: 0.02) was observed between TSH and BMI. This suggests that as the TSH levels increase, BMI also increases, indicates a direct potential relationship between TSH and BMI.

The linear regression analysis shows a weak, significant positive correlation between TSH and BMI (R: 0.070, p: 0.02). The R² value is 0.005, indicates that the 0.5% variation in TSH is contributed by the BMI. The F value is 0.948 and the p-value is 0.33, shows that the regression model is not significant. The beta coefficient for BMI indicates that as BMI increases, TSH increases by 0.010 units; however, this effect is not statistically significant (p: 0.331).

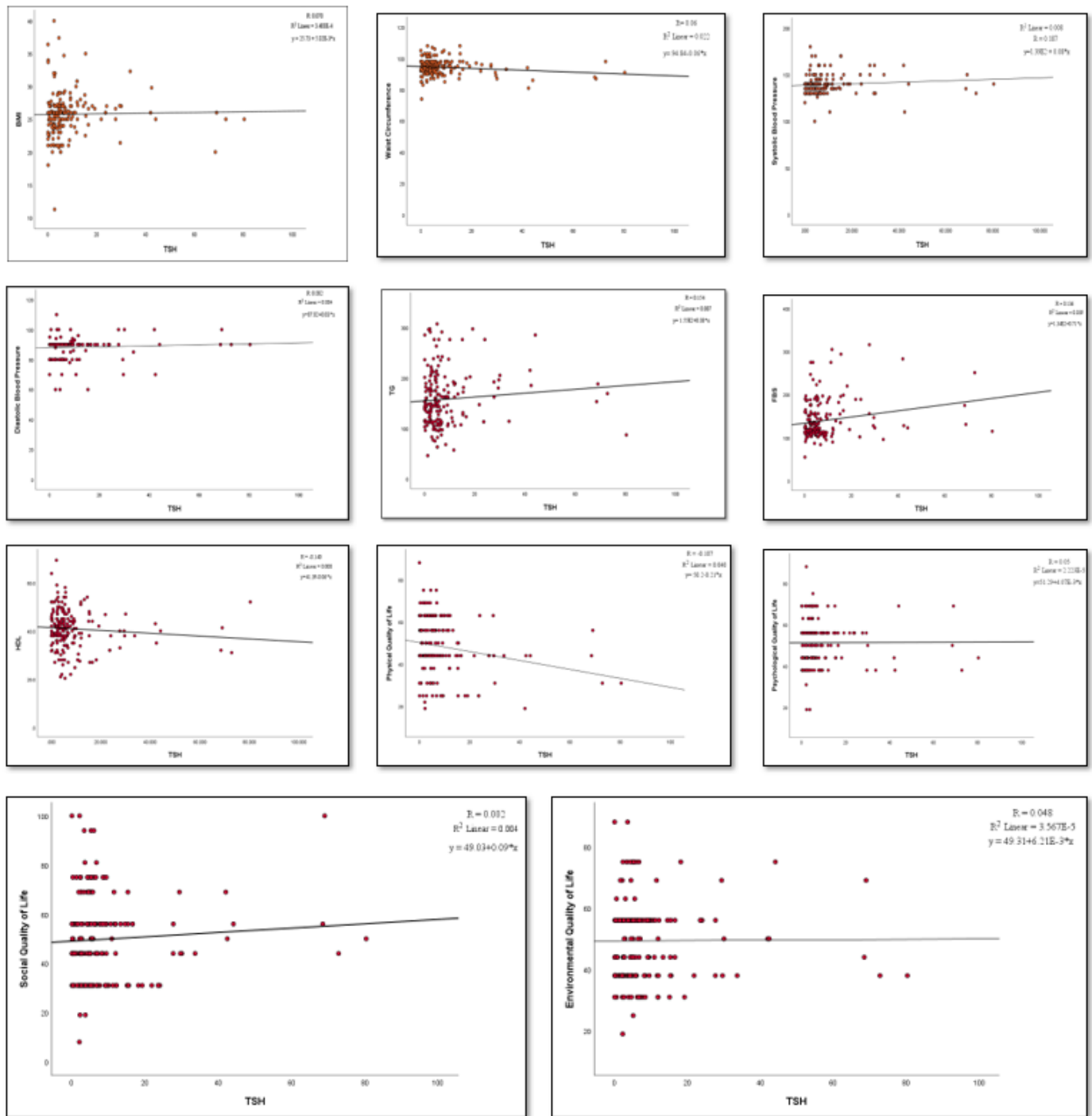


Figure 2: Association of TSH with Metabolic Components and Quality of Life.

Association between TSH and Waist Circumference

A weak positive association was observed between TSH and WC (R: 0.068) but not statistically significant (p: 0.86). TSH may not be a direct factor affecting WC in this specific population.

The linear regression analysis shows a weak positive correlation between TSH and WC (R: 0.068) but not significant (p: 0.86). The R^2 value of 0.005 implies that the WC contributes to the 0.5% variation in TSH. The F-value of 0.922 and the p-value of 0.338

shows that the regression model is not significant. While the beta coefficient for WC suggests a potential increase in TSH by 0.006 units with increasing WC, but this trend is not statistically significant (p=0.338).

Association between TSH and Systolic Blood Pressure

A significant positive association was found between TSH and SBP (R: 0.187, p: 0.008). This suggests that as the TSH increases,

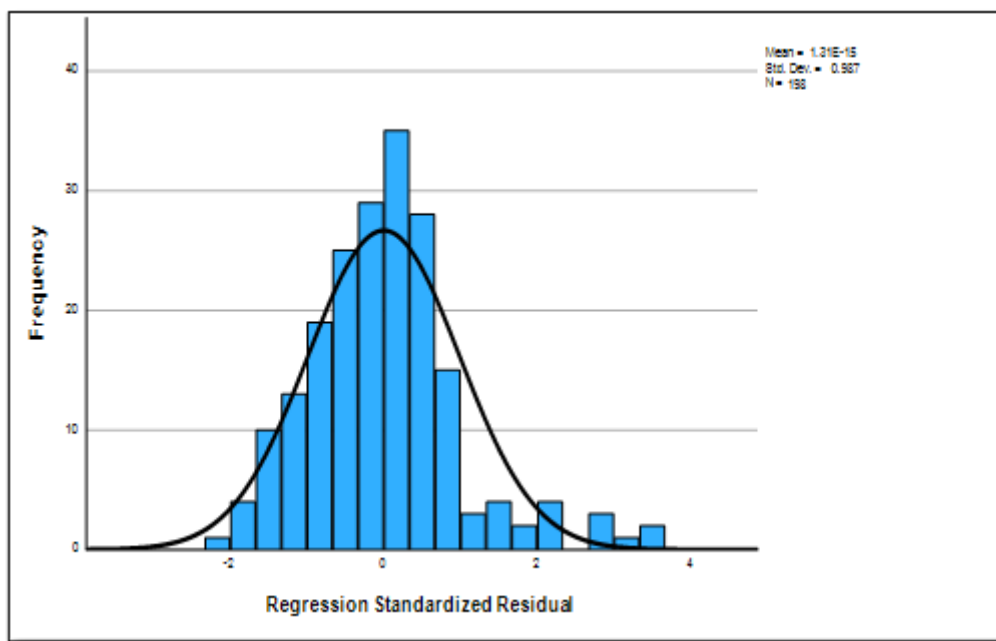


Figure 3: Regression Standardized Residual.

Table 3: Association of Thyroid Hormones with Metabolic Components and Quality of Life.

Variables	R	Interpretation	p
TSH-BMI	0.007	Very weak positive correlation	0.02
TSH-Waist Circumference	0.06	Very weak positive correlation	0.86
TSH-Systolic Blood Pressure	0.187	Weak positive correlation	0.008
TSH-Diastolic Blood Pressure	0.082	Very weak positive correlation	0.28
TSH-Triglycerides	0.154	Weak positive correlation	0.030
TSH-High Density Lipoprotein	-0.140	Weak negative correlation	0.04
TSH-Fasting Blood Sugar	0.136	Weak positive correlation	0.05
TSH-Physical Domain	-0.187	Weak negative correlation	0.008
TSH-Psychological Domain	0.05	Very weak positive correlation	0.172
TSH-Social Domain	0.002	Very weak positive correlation	0.98
TSH-Environmental Domain	0.04	Very weak positive correlation	0.49

* Spearman's Correlation.

SBP tends to increase, indicating a potential association between TSH levels and SBP.

The R^2 value of 0.040 implies that SBP contributes to 4% of the variation in TSH. The F value of 8.064 and the p -value of 0.005 imply that the regression model is statistically significant. The beta coefficient for SBP suggests that SBP increases, TSH increases by 0.009 units and this effect is statistically significant.

Association between TSH and Diastolic Blood Pressure

TSH is weakly correlated with DBP (R: 0.082) but was not statistically significant (p : 0.28). The findings suggest that TSH levels do not significantly influence DBP.

The linear regression analysis shows a very weak, non-significant correlation between DBP and TSH (R: 0.082, p : 0.28). The R^2 value of 0.007 implies that DBP contributes to 0.7% of the variation in TSH. The F value of 1.409 and the p -value of 0.237 indicated that the regression model is not statistically significant. The beta coefficient for DBP suggests that as DBP increases, TSH increases by 0.006 units; but this effect is not statistically significant.

Association between TSH and Triglycerides

A weak positive association was found between TSH and TG (R: 0.154), but the correlation was not significant (p : 0.030). There may be an association between TSH and TG, but it is not strong enough to be considered a reliable predictor of TG based on TSH.

Table 4: Regression Analysis between TSH and Metabolic Components.

Dependent Variable	TSH	TSH	TSH	TSH	TSH	TSH	TSH	TSH	TSH	TSH	TSH
Predictors	BMI	WC	SBP	DBP	FBS	TG	HDL	Physical QOL	Psychological QOL	Social QOL	Environmental QOL
R-value	0.070	0.06	0.19	0.08	0.13	0.15	-0.14	0.18	0.055	0.002	0.058
R square value	0.005	0.00	0.04	0.007	0.01	0.02	0.02	0.03	0.003	0.000	0.003
Adjusted R square value	0.000	0.00	0.03	0.002	0.01	0.01	0.01	0.03	-0.002	-0.005	-0.002
ANOVA											
Sum of Squares (Regression and Residual)	0.206	0.19	1.68	0.30	0.78	1.00	0.83	1.49	0.12	0.000	0.023
	42.37	42.39	40.91	42.29	41.81	41.5	41.75	41.10	42.36	6.769	6.748
Mean Square (Regression and Residual)	0.206	0.19	1.68	0.30	0.78	1.00	0.83	1.49	0.12	0.000	0.023
	0.217	0.21	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.034	0.034
F value	0.948	0.92	8.06	1.40	3.67	4.75	3.93	7.14	0.59	0.001	0.676
P value	0.331	0.33	0.00	0.23	0.05	0.03	0.04	0.008	0.44	0.980	0.412
Coefficients											
Beta (Constant*, Variable)	0.567	1.389	-0.40	0.29	0.61	0.61	1.14	1.14	0.694	.923	.964
	0.10	0.006	0.00	0.006	0.001	0.001	- 0.008	- 0.007	0.002	-1.98	-.001
Standard Error (Constant*, Variable)	0.258	0.596	0.43	0.44	0.11	0.097	0.16	0.127	0.694	0.041	0.053
	0.10	0.006	0.03	0.005	0.001	0.001	0.004	0.003	0.002	0.001	0.001
Standardized Coefficients Beta	0.070	0.068	0.19	0.08	0.13	0.154	- 0.14	-0.187	0.055	-0.002	-0.058
t value (Constant*, Variable)	2.199	2.329	- 0.93	0.66	5.61	6.373	6.80	9.02	4.198	22.66	18.215
	0.974	960	2.84	1.18	1.91	2.179	-1.98	- 2.67	0.769	-0.026	-0.822
P value (Constant*, Variable)	0.029	0.021	0.34	0.50	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	0.331	0.338	0.05	0.23	0.05	0.030	0.04	0.008	0.443	0.980	0.412
95% Confidence Interval (Constant*, Variable)	0.05	0.21	-1.25	-0.57	0.400	0.427-	0.812 -	0.894	0.368	0.843	0.860
	- 1.07	-	-	-	-	0.809	1.475	-	-	-	-
		2.56	0.44	1.16	0.833			1.394	1.020	1.004	1.069
	- 0.10	0.01	0.00	0.000	0.000	0.000	- 0.016	-0.012	-0.004	-0.002	-0.003
	- 0.02	- 0.02	- 0.01	-	-	-	-	-	-	-	-
				0.01	0.003	0.002	0.000	-0.002	0.009	0.002	0.001

The R^2 value of 0.024 implies that TG contributes to 2.4% of the variation in TSH. The regression model is statistically significant, as indicated by the F value of 4.750 and the p -value of 0.030. The beta coefficient for TG suggests that as TG increase, TSH increases by 0.001 units, which is statistically significant.

Association between TSH and Fasting Blood Sugar (FBS)

A positive correlation was obtained between TSH and FBS (R : 0.136) but not statistically significant (p : 0.05). The observation suggests that while there is a slight tendency for FBS to increase as TSH increases, the relationship is very weak.

The R^2 value of 0.018 implies that FBS contributes to 1.8% of the variation in TSH. The F value of 3.677 and the p -value of 0.05 indicated that the regression model is statistically significant. The beta coefficient for FBS suggests that as FBS increases, TSH increases by 0.001 units.

Association between TSH and High-Density Lipoprotein (HDL)

A significant negative association was found between TSH and HDL levels (R : -0.140, p : 0.04). This suggests there is an inverse relationship between TSH and HDL.

The R^2 value of 0.020 implies that HDL contributes to 2.0% of the variation in TSH. The regression model is statistically significant, as indicated by the F value of 3.933 and the p -value of 0.04. The beta coefficient for HDL suggests that as HDL increases, TSH decreases by 0.008 units.

Association between TSH and the domains of Quality of Life (QOL)

Association between TSH and Physical domain of Quality of Life (QOL)

A negative significant correlation was observed between TSH and Physical Domain of QOL (R : -0.187 p : 0.008). This suggests an inverse relationship between TSH and Physical QOL domain. When the TSH levels increase, hypothyroid symptoms intensify and the patients become weaker physically.

The R^2 value of 0.035 implies that the physical domain of quality of life contributes to 3.5% of the variation in TSH. The regression model is statistically significant, as indicated by the F value of 7.141 and the p -value of 0.008. The beta coefficient for the physical domain of QOL suggests that as the physical domain of QOL increases, TSH decreases by 0.007 units.

Association between TSH and Psychological domain of Quality of Life (QOL)

A weak positive correlation was observed between TSH and psychological Domain (R : 0.055) but not statistically significant (p : 0.172). Even though there is a weak positive relationship between TSH and the psychological domain, the data are not sufficient to substantiate a strong significant association between TSH and the psychological domain of QOL.

The linear regression analysis shows a very weak positive correlation between the psychological domain of QOL and TSH (R : 0.055), but not statistically significant (p : 0.443). The R^2 value of 0.003 implies that the psychological domain of quality of life contributes 0.3% of the variation in TSH. The F value is 0.591

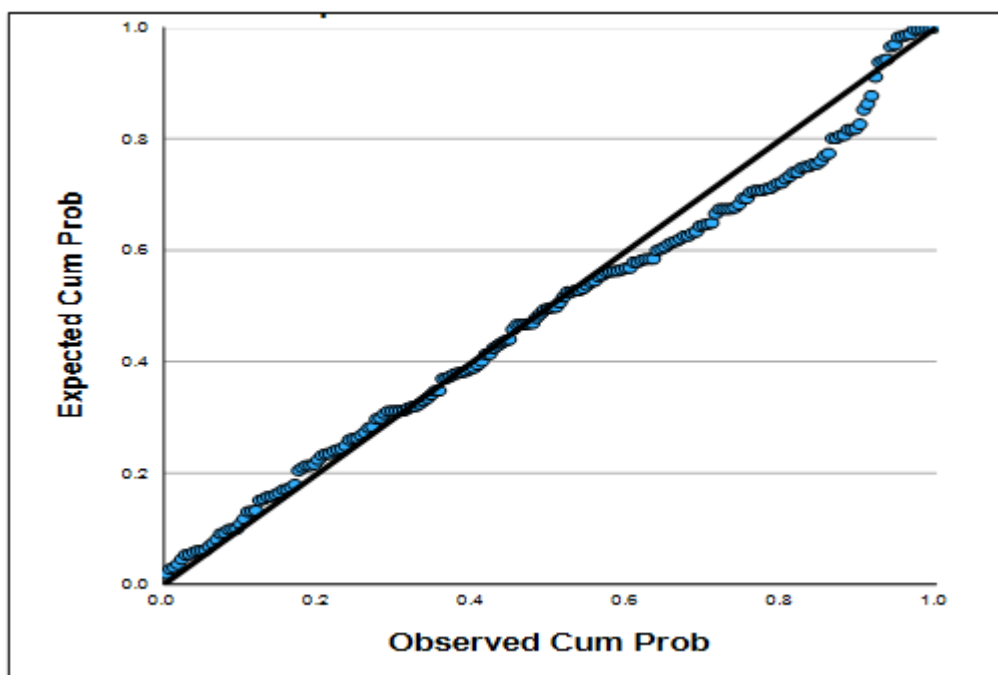


Figure 4: Normal P-Plot of Regression Standardized Residual.

and the p -value is 0.443 implies that the regression model is not significant.

Association between TSH and Social domain of Quality of Life (QOL)

A weak positive correlation coefficient exists between TSH and the social domain of QOL (R : 0.002) but is not statistically significant (p : 0.98).

The regression analysis shows an extremely weak correlation between the social domain of quality of life and TSH levels (R : 0.002) but not statistically significant (p : 0.980). The F value of 0.001 and p -value of 0.980 imply that the regression model is not significant. The beta coefficient for the social domain of QOL suggests that the social domain of QOL increases, as the TSH decreases by 1.98 units.

Association between TSH and Environmental domain of Quality of Life (QOL)

The correlation analysis of TSH and the Environmental Domain of QOL showed a very weak positive correlation (R : 0.048) but not statistically significant ($p=0.49$) (Table 3), (Figure 2).

The regression analysis shows a weak positive correlation between the environmental domain of QOL and TSH levels (R : 0.058) but is not statistically significant (p : 0.412). The R^2 value of 0.003 implies that the environmental domain of QOL contributes 0.3% of the variation in TSH. The F value of 0.676 and p -value of 0.412 indicate that the regression model is not significant. The beta coefficient for the environmental domain of QOL suggests that as the environmental domain of QOL increases, TSH decreases by 0.001 units (Table 4, Figures 3 and 4).

DISCUSSION

Thyroid hormones play a critical role in regulating metabolism. Since thyroid hormones have an important role in metabolism, HT increases the risk for metabolic syndrome (Iwen *et al.*, 2013).

In this study, TSH was found to have a significant positive correlation with BMI (R : 0.07, p : 0.02), SBP (R : 0.187, p : 0.008), TG (R : 0.154, p : 0.03) and FBS (R : 0.136, p : 0.05) and a negative significant correlation with HDL (R : -0.140, p : 0.04). These findings were similar to the study conducted by Khatiwada S *et al.* and Bensenor IM *et al.*, where a positive correlation was observed for DBP, blood glucose and TG with TSH. However, HDL and TSH had a negative correlation (Khatiwada *et al.*, 2016; Bensenor *et al.*, 2015). Similarly, a negative correlation between SBP and WC with TSH was observed in their study, but this correlation was not significant, which contradicts the findings of the present study. In contrast to the findings of this study, Huang CY *et al.* found no correlation between serum TSH levels and MetS, but strong correlations with high serum T3 levels and no clear correlations with low serum T4 (Huang and Hwang, 2016).

The current study found that females are at a greater risk of developing metabolic syndrome (76%). The findings can be compared with the study conducted by He J *et al.*, where metabolic syndrome is more prevalent in women with hypothyroidism than in men (He *et al.*, 2021).

Regarding QOL, hypothyroid patients with MetS experience poor QOL, with the psychological domain better than the physical, social and environmental domains. A negative correlation was observed between TSH and the physical domain of QOL, indicating that higher TSH levels are associated with a decline in QOL. These findings are comparable to studies by Ghamri R *et al.* and Kelderman-Bolk *et al.*, which also observed a decline in QOL with increasing TSH (Ghamr *et al.*, 2022; Kelderman-Bolk *et al.*, 2015).

The current study provides comprehensive insights into the impact of HT on metabolic diseases and overall QOL. Through a multifaceted analysis, the research highlights the association of hypothyroidism with metabolic components and QOL.

CONCLUSION

Hypothyroidism is associated with BMI, WC, BP and TG; however, it has a negative relationship with HDL. Hypothyroidism patients with metabolic syndrome have a poor quality of life, particularly in the physical domain. Screening of MetS in hypothyroid patients is important for the early detection and prevention of disease-related complications.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

HT: Hypothyroidism; **MetS**: Metabolic Syndrome; **QOL**: Quality of Life; **BP**: Blood Pressure; **NCEP ATP III**: National Cholesterol Education Program Adult Treatment Panel III; **T4**: Thyroxine; **TSH**: Thyroid Stimulating Hormone; **T3**: Triiodothyronine; **TG**: Triglycerides; **WC**: Waist Circumference; **HDL**: High-Density Lipoprotein; **FBS**: Fasting Blood Sugar; **BMI**: Body Mass Index; **SBP**: Systolic Blood Pressure; **DBP**: Diastolic Blood Pressure.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Central Ethics Committee, Nitte (Deemed to be University), (Ref. No: NU/CEC/2022/317). Informed consent was obtained from every subject involved in the study.

AUTHOR CONTRIBUTIONS

Bipin Shaji: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Data Interpretation, Visualization, Writing-original draft, Writing-review and editing, Project administration. Juno Jerold Joel: Conceptualization, Methodology, Project administration, Writing-review and editing, Supervision. Raghava Sharma: Conceptualization, Methodology, Project administration, Writing-review and editing, Supervision. Shraddha Shetty: Methodology, Data Curation, Formal Analysis, Data Interpretation, Visualization, Writing-review and editing.

REFERENCES

- Benseñor, I. M., Goulart, A. C., Molina, M. D., de Miranda, É. J. P., Santos, I. S., & Lotufo, P. A. (2015). Thyrotropin levels, insulin resistance and metabolic syndrome: A cross-sectional analysis in the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). *Metabolic Syndrome and Related Disorders*, 13(8), 362–369. <https://doi.org/10.1089/met.2015.0045>
- Chaker, L., Bianco, A. C., Jonklaas, J., & Peeters, R. P. (2017). Hypothyroidism. *The Lancet*, 390(10101), 1550–1562. [https://doi.org/10.1016/S0140-6736\(17\)30703-1](https://doi.org/10.1016/S0140-6736(17)30703-1)
- Chiovato, L., Magri, F., & Carlé, A. (2019). Hypothyroidism in context: Where We've been and where We're going. *Advances in Therapy*, 36(Suppl. 2), 47–58. <https://doi.org/10.1007/s12325-019-01080-8>
- Fahed, G., Aoun, L., Bou Zerdan, M., Allam, S., Bou Zerdan, M., Bouferaa, Y., & Assi, H. I. (2022). Metabolic syndrome: Updates on pathophysiology and management in 2021. *International Journal of Molecular Sciences*, 23(2), 786. <https://doi.org/10.3390/ijms23020786>
- Garmendia Madariaga, A., Santos Palacios, S., Guillén-Grima, F., & Galofré, J. C. (2014). The incidence and prevalence of thyroid dysfunction in Europe: A meta-analysis. *The Journal of Clinical Endocrinology and Metabolism*, 99(3), 923–931. <https://doi.org/10.1210/jc.2013-2409>
- Ghamri, R., Babaker, R., Ezzat, S., Alsaedi, H., Alkhamisi, M., Arbaein, R., Alyahya, R., Fayraq, S., & Alamri, S. (2022). Assessment of quality of life among patients with primary hypothyroidism: A case-control study. *Cureus*, 14(10), Article e29947. <https://doi.org/10.7759/cureus.29947>
- Gluvic, Z., Sudar, E., Tica, J., Jovanovic, A., Zafirovic, S., Tomasevic, R., & Isenovic, E. R. (2015). Effects of levothyroxine replacement therapy on parameters of metabolic syndrome and atherosclerosis in hypothyroid patients: A prospective pilot study. *International Journal of Endocrinology*, 2015, Article 147070. <https://doi.org/10.1155/2015/147070>
- He, J., Lai, Y., Yang, J., Yao, Y., Li, Y., Teng, W., & Shan, Z. (2021). The relationship between thyroid function and metabolic syndrome and its components: A cross-sectional study in a Chinese population. *Frontiers in Endocrinology (Lausanne)*, 12, Article 661160. <https://doi.org/10.3389/fendo.2021.661160>
- Huang, C.-Y., & Hwang, L.-C. (2016). The association of thyroid hormones and TSH with the metabolic syndrome in euthyroid Taiwanese individuals. *Endocrine Practice*, 22(11), 1303–1309. <https://doi.org/10.4158/EP161260.0R>
- Iwen, K. A., Schröder, E., & Brabant, G. (2013). Thyroid hormones and the metabolic syndrome. *European Thyroid Journal*, 2(2), 83–92. <https://doi.org/10.1159/000351249>
- Jonklaas, J., Bianco, A. C., Bauer, A. J., Burman, K. D., Cappola, A. R., Celi, F. S., Cooper, D. S., Kim, B. W., Peeters, R. P., Rosenthal, M. S., Sawka, A. M., & American Thyroid Association Task Force on Thyroid Hormone Replacement. (2014). Guidelines for the treatment of hypothyroidism: Prepared by the American Thyroid Association task force on thyroid hormone replacement. *Thyroid*, 24(12), 1670–1751. <https://doi.org/10.1089/thy.2014.0028>
- Kelderman-Bolk, N., Visser, T. J., Tijssen, J. P., & Berghout, A. (2015). Quality of life in patients with primary hypothyroidism related to BMI. *European Journal of Endocrinology*, 173(4), 507–515. <https://doi.org/10.1530/EJE-15-0395>
- Khatiwada, S., Sah, S. K., Kc, R., Baral, N., & Lamsal, M. (2016). Thyroid dysfunction in metabolic syndrome patients and its relationship with components of metabolic syndrome. *Clinical Diabetes and Endocrinology*, 2, 3. <https://doi.org/10.1186/s40842-016-0021-0>
- Kumar, P., Mukherji, A., & Roy, A. (2022). Prevalence of hypothyroidism in the population of west Bokaro coal mine area, Jharkhand: A hospital-based observational study. *Cureus*, 14(9), Article e28733. <https://doi.org/10.7759/cureus.28733>
- Lee, S. Y., & Pearce, E. N. (2022, March). Assessment and treatment of thyroid disorders in pregnancy and the postpartum period. *Nature Reviews. Endocrinology*, 18(3), 158–171. <https://doi.org/10.1038/s41574-021-00604-z>
- Mavromati, M., & Jornayvaz, F. R. (2021). Hypothyroidism-associated dyslipidemia: Potential molecular mechanisms leading to NAFLD. *International Journal of Molecular Sciences*, 22(23), Article 12797. <https://doi.org/10.3390/ijms222312797>
- Muller, R., Liu, Y.-Y., & Brent, G. A. (2014). Thyroid hormone regulation of metabolism. *Physiological Reviews*, 94(2), 355–382. <https://doi.org/10.1152/physrev.00030.2013>
- National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). (2002). National Cholesterol Education Program (NCEP) expert panel on detection, evaluation and treatment of high blood cholesterol in adults (adult treatment Panel III). Third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation and treatment of high blood cholesterol in adults [Final report]. *Circulation*, 106(25), 3143–3421. <https://doi.org/10.1161/circ.106.25.3143>
- Razvi, S., Mrabeti, S., & Luster, M. (2020). Managing symptoms in hypothyroid patients on adequate levothyroxine: A narrative review. *Endocrine Connections*, 9(11), R241–R250. <https://doi.org/10.1530/EC-20-0205>
- Shaji, B., & Joel, J. J. (2022). Impact of hypothyroidism on metabolic and cognitive dysfunction: A comprehensive review. *Journal of Young Pharmacists*, 14(4), 349–354. <https://doi.org/10.5530/jyp.2022.14.71>
- Shivaprasad, C., Rakesh, B., Anish, K., Annie, P., Amit, G., & Dwarakanath, C. S. (2018). Impairment of health-related quality of life among Indian patients with hypothyroidism. *Indian Journal of Endocrinology and Metabolism*, 22(3), 335–338. https://doi.org/10.4103/ijem.IJEM_702_17
- Unnikrishnan, A. G., Kalra, S., Sahay, R. K., Bantwal, G., John, M., & Tewari, N. (2013). Prevalence of hypothyroidism in adults: An epidemiological study in eight cities of India. *Indian Journal of Endocrinology and Metabolism*, 17(4), 647–652. <https://doi.org/10.4103/2230-8210.113755>

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