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Relation between Thyroid Function Tests and Body Mass Index among Thyroid Dysfunction Patients

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ABSTRACT

Background: Obesity has the potential to impact thyroid function through various pathways, even in individuals considered euthyroid. The relationship between thyroid function and body mass index (BMI) remains a subject of ongoing debate. Therefore, the primary objective of this study was to ascertain the correlation existing among thyroid stimulating hormone (TSH), thyroid hormones, and BMI in patients experiencing thyroid dysfunction within the context of the Smart Health Tower. **Methods:** This cross-sectional study was conducted in Smart Health Tower in Sulaimani city from November 9, 2021, to March 1, 2022. One hundred and sixty-six patients with thyroid dysfunction (128 individuals had hypothyroidism, eight individuals had hyperthyroidism, and 30 individuals were the other type of thyroid dysfunction) were enrolled in this study. Their mean age was 43.62 ± 11.17 and 50.6% of the participation were male. Patients were divided into four groups based on BMI value: Underweight (BMI <18.5 kg/m^2), normal (BMI: 18.5–24.9 kg/m^2), overweight (BMI: 25–29.9 kg/m^2), and obese (BMI ≥30 kg/m^2). **Results:** The highest rate of age group was between (30 and 40) years old (84%) of them were male. The participants with higher BMI had higher TSH and this trend continued from underweight to Obese. The mean TSH of the underweight group was 0.47 ± 0.61 mIU/L, the normal weight group 1.5 ± 1.91 mIU/L, the overweight group 2.8 ± 3.87 mIU/L and the obese group 2.7 ± 2.37 mIU/L. **Conclusion:** A significant relationship between serum TSH and BMI and mean TSH increased as BMI increased. Further large-scale data from the population are required to confirm these findings.

Index Terms: Body Mass Index, Overweight, Obesity, Thyroid Dysfunction, Thyroid Stimulating Hormone

1. INTRODUCTION

Thyroid hormones play a pivotal role in numerous physiological processes, including the regulation of basal metabolic rate and the facilitation of lipogenesis, lipolysis, and gluconeogenesis [1] Patients with thyroid disorders may experience alterations in their body weight and composition [2].

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Hypothyroidism induces water retention, concurrent with diminished renal flow, hyaluronic acid accumulation, and reduced basal metabolism and thermogenesis [3]. Facial edema can create the semblance of obesity, a phenomenon termed myxedema, while profound hypothyroidism can prompt skin hyperkeratosis and heightened sensitivity to cold. Hypothyroid patients commonly experience sluggish peristalsis, culminating in chronic constipation, often leading to weight gain primarily due to fluid retention rather than adipose tissue accretion [2], [4].

Moreover, certain studies have identified a higher prevalence of subclinical hypothyroidism among individuals classified as

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obese [5]. In addition, there exists a direct association between obesity and hypothyroidism. The 2012 guidelines from the American Thyroid Association regarding the management of hypothyroidism underscore the absence of definitive data in this area. These recommendations emphasize that although a common perception exists that hypothyroidism and obesity are intertwined, studies indicate a correlation between body weight (BMI) and levels of thyroid-stimulating hormone (TSH) [6].

Individuals afflicted with hyperthyroidism experience heightened stimulation of the beta-adrenergic receptor, leading to elevated basal metabolism, thermogenesis, and overall energy expenditure. Consequently, they are predisposed to weight loss [7], as a result of triiodothyronine's anorexigenic effect; hyperthyroidism can prompt accelerated gastrointestinal transit and intermittent anorexia [2]. These factors may have contributed to the perception of a direct correlation between low weight and hyperthyroidism. Similar to hypothyroidism, conclusive evidence linking low weight and hyperthyroidism remains insufficient [8].

Given the observed physiological changes, one might logically expect that administering specific medications to restore optimal hormone levels would result in individuals with thyroid dysfunction returning to their pre-dysfunctional body weight. However, numerous investigations have shown that this expectation is not consistently met [9], [10].

1.1. The Aim of the Study

The study aimed to investigate the correlation TSH, thyroid hormones, and BMI in patients with thyroid dysfunction at the Smart Health Tower Hospital in Sulaimani City.

2. SUBJECTS AND METHODS

This is a quantitative cross-sectional study that was approval from the regional research committee of Sulaimani health administration, and the scientific research committee of the College of Nursing, University of Sulaimani, Sulaimani City/Iraq.

One hundred and sixty-six patients who complained from thyroid dysfunction previously tested in Smart h Health Tower Hospital (128 individuals had hypothyroidism, eight individuals had hyperthyroidism and 30 individuals were the other type of thyroid dysfunction) were enrolled in this study, a questionnaire, developed from a literature review, covered demographic information, and thyroid test value. Patients were divided into four groups based on BMI value as described in Table 1 [11]:

Table 1: Categorizing of BMI [11]

BMI	
Underweight	<18.5
Normal	18.5–24.9
Overweight	25–29.9
Obese	>30

BMI: Body mass index

2.1. Inclusion Criteria

All patients with thyroid problem age between 18 and 80 years. An able to give consent for participation and clinically stable patient was included in the study.

2.2. Validity

Five experts reviewed the questionnaire for this study and provided recommendations, leading to adjustments for clarity and relevance. As a result, the final version of the questionnaire was considered valid for gathering data.

2.3. Pilot Study

A pilot study was carried out in November 1, 2021, involving 15 participants selected from the main study sample.

2.4. Reliability

The reliability of the findings related to thyroid function tests and body mass index (BMI) was assessed using both the internal consistency (split-half) approach and the Cronbach Alpha Correlation Coefficient. This analysis resulted in a significant correlation coefficient of ($r = 0.80$), indicating a high level of reliability.

2.5. Statistical Analysis

Data were organized and coded into computer files using the Statistical Package for the Social Science (V20). Data were analyzed through the application of (frequency, percentage, mean with stander deviation, independent samples t-test, and One-way analysis of variance (F-test), *P*-value as: High significant ($P < 0.001$), significant ($P \leq 0.05$), non-significant ($P > 0.05$).

3. RESULTS

Table 2 shows the sociodemographic characteristics, the mean age was (43.62 ± 11.17) years, the majority of participants (33.7%) were aged between (30 and 40) years, (50.6%) of participants male, (38.5%) of them were graduated from high school, more than two-third of patients were living Urban (60.2%), Regarding to blood group; (49.4%) of the patients had blood group O+ and (26.5%) of them had A+, blood

Table 2: Sociodemographic characteristic of the patients

Variables	Items	Frequency (F)	%
Age (years)	<30	16	9.6
	30–40	56	33.7
	41–50	52	31.3
	>50	42	25.3
	Mean±S. D	43.62±11.17	
Gender	Male	84	50.6
	Female	82	49.4
Level of education	Primary school	32	19.3
	High school	64	38.5
	Illiterate	28	16.9
	Student	2	1.2
	College	40	24.1
Resident area	Urban	100	60.2
	Suburban	66	39.8
Blood group	A+	44	26.5
	AB+	8	4.8
	B-	6	3.6
	B+	26	15.7
	O+	82	49.4
Total		166	100

group, (15.7%) of them were B+, (4.8%) were AB+, and (3.6%) of them were B-.

More than two-third (64%) of the sample had hypothyroidism which complained from fatigue and muscle weakness (62.65%), sweating (71.08%), nervousness, anxiety, irritability (65.06%), as shown in (Table 3).

Only 4.82% of the patients exhibited symptoms of hyperthyroidism, reporting complaints such as constipation, dry skin, depression, and an enlarged thyroid gland. In addition, fatigue, muscle weakness, muscle aches, tenderness, and stiffness were observed in 3.61% of the cases, as illustrated in (Table 4).

(Table 5) represents the other types of thyroid dysfunction. Most participants (40%) had gravis disease and (13.33%) had parathyroid lesion and parathyroid adenoma.

More than two-third of the patients had overweight (39.8%) and obese (36.1%) as shown as Table 6.

Table 7 indicated that there was no statistically significant difference in the mean values of T3, T4, and BMI parameters ($P > 0.05$). However, a highly significant difference was observed between BMI parameters and the mean of TSH ($P = 0.006$). As BMI increased, the mean TSH within the BMI range also exhibited an increase. Individuals with

Table 3: Distribution of samples according to hypothyroidism with their symptoms

Hypothyroidism	No		Yes		Total
	F	%	F	%	F
Hypothyroidism	38	22.89	128	77.11	166
Sign and symptoms					
Unintentional weight loss	160	96.39	6	3.61	166
Rapid heartbeat	90	54.22	76	45.78	166
Irregular heartbeat	114	68.67	52	31.33	166
Pounding of your heart	116	69.88	50	30.12	166
Increased appetite	112	67.47	54	32.53	166
Nervousness, anxiety and irritability	58	34.94	108	65.06	166
Tremor	78	46.99	88	53.01	166
Sweating	28	28.92	118	71.08	166
Changes in bowel pattern	104	62.65	62	37.35	166
Increased sensitivity to heat	82	49.40	84	50.60	166
Changes in menstrual pattern	154	92.77	12	7.23	166
An enlarged thyroid gland (goiter)	96	57.83	70	42.17	166
Fatigue, muscle weakness	62	37.35	104	62.65	166
Difficulty sleeping	82	49.40	84	50.60	166
Skin thinning	140	84.34	26	15.66	166
Fine, brittle hair	140	84.34	26	15.66	166

Table 4: Distribution of samples according to hyperthyroidism and their symptoms

Hyperthyroidism	No		Yes		Total
	F	%	F	%	F
Hyperthyroidism	158	95.18	8	4.82	166
Sign and symptoms					
Fatigue	160	96.39	6	3.61	166
Increased sensitivity to cold	164	98.80	2	1.20	166
Constipation	158	95.18	8	4.82	166
Dry skin	158	95.18	8	4.82	166
Weight gain	164	98.80	2	1.20	166
Puffy face	166	100.00	0	0.00	166
Hoarseness of voice	166	100.00	0	0.00	166
Muscle weakness	160	96.39	6	3.61	166
Elevated blood cholesterol level	166	100.00	0	0.00	166
Muscle aches, tenderness, and stiffness	160	96.39	6	3.61	166
Pain, stiffness, or swelling in joints	164	98.80	2	1.20	166
Heavier than normal or irregular menstrual period	166	100.00	0	0.00	166
Thinning hair	164	98.80	2	1.20	166
Slow heart rate	162	97.59	4	2.41	166
Depression	158	95.18	8	4.82	166
Impaired memory	166	100.00	0	0.00	166
Enlarged thyroid gland (goiter)	158	95.18	8	4.82	166

higher BMI values demonstrated elevated TSH levels, and this pattern persisted from underweight to obese categories. Specifically, the mean TSH levels were 0.47 ± 0.61 mIU/L for the underweight group, 1.5 ± 1.91 mIU/L for the normal weight group, 2.8 ± 3.87 mIU/L for the overweight group, and 2.7 ± 2.37 mIU/L for the obese group.

4. DISCUSSION

The observation that over one-third of the participants fell within the age range of 30–40 years is consistent with a recent study indicating a higher prevalence of thyroid dysfunction in young to middle-aged adults [12]. This age group represents a period of life characterized by hormonal changes and metabolic shifts, which may predispose individuals to thyroid disorders such as subclinical hypothyroidism or autoimmune thyroiditis.

Furthermore, the presence of a quarter of participants aged over 50 years corroborates recent research highlighting the impact of aging on thyroid function [13], [14]. Aging is associated with alterations in thyroid hormone levels, including changes in TSH secretion and thyroid hormone metabolism, which can contribute to the development of thyroid dysfunction in older individuals.

Notably, subclinical disturbances of thyroid function are more prevalent than overt diseases in the elderly. Furthermore, the clinical manifestation of thyroid diseases in older individuals differs from that observed in younger subjects; symptoms are often more subtle and are frequently attributed to normal aging. Consequently, these subtle symptoms demand special attention when assessing the health of elderly individuals [5].

In the present study, more than half of the participants were male, in contrast to the findings of [15]. The aforementioned authors reported a prevalence ratio for functional alterations favoring females over males (8:5), and this ratio tended to increase with aging [15]. In this study, it was found that nearly half of the patients had blood type O+, while approximately one-quarter of them had blood type A+. These findings are consistent with those reported by [16], who noted a higher proportion of individuals in the control group belonging to these blood groups.

More than two-thirds of the sample exhibited hypothyroidism, while the prevalence of Hyperthyroidism disorder was comparatively low. These findings can be elucidated by considering that the most common cause of hyperthyroidism in iodine-sufficient areas is Graves' disease. In Sweden, the annual incidence of Graves' disease is on the rise, with 15–30

Table 5: Distribution of sample according other types of thyroid dysfunction

Other type	F (F)	%
Gravis disease	12	40
PCT	2	6.67
Grade 1 diffuse	2	6.67
Go	2	6.67
Parathyroid lesion	4	13.33
Parathyroid adenoma	4	13.33
Metastatic carcinoma	2	6.67
Thyroiditis	2	6.67
Total	30	100

Table 6: Distribution of samples according to the body mass index

Body mass index	F (F)	%
BMI		
Underweight	8	4.8
Normal	32	19.3
Overweight	66	39.8
Obese	60	36.1
Total	166	100

BMI: Body mass index

Table 7: Relationship between thyroid functions test and BMI parameters

Thyroid function test mIU/L	BMI			
	Underweight	Normal	Overweight	Obese
T3				
Mean±S. D	2.42±1.55	2.94±1.79	3.67±3.97	3.5±3.99
Test	F-test=0.257		*P*=0.856	
T4				
Mean±S.D	82.02±11.99	92.74±40.67	106.56±68.5	107.6±48.3
Test	F-test=0.488		*P*=0.691	
TSH				
Mean±S.D	0.47±0.61	1.5±1.91	2.8±3.87	2.7±2.37
Test	F-test=4.515		*P*=0.006	

BMI: Body mass index, TSH: Thyroid stimulating hormone new cases per 100,000 inhabitants in the 2000s. The etiology of Graves' disease is believed to be multifactorial, stemming from the loss of immunotolerance and the development of autoantibodies that stimulate thyroid follicular cells by binding to the TSH receptor. Numerous studies have presented evidence supporting a genetic predisposition to Graves' disease [17], [18].

The present investigation unveils a notable prevalence of overweight and obesity among the patient cohort, with over two-thirds of individuals exhibiting these conditions. This underscores the imperative of incorporating weight management strategies into the therapeutic approach for thyroid dysfunction, given the exacerbating effect of obesity on the complications associated with thyroid disorders [19], [20].

Moreover, a statistically significant disparity was discerned between BMI parameters and the mean of TSH. This discernible association between thyroid function and BMI underscores the intricate interrelation between metabolic regulation and thyroid hormone activity. The previous studies have elucidated those disruptions in thyroid function, particularly hypothyroidism, can perturb metabolic rate and energy expenditure, frequently resulting in weight gain and hindered weight loss [6], [21]. This observation aligns with the findings of [22], who demonstrated a positive correlation between BMI and TSH.

Contradictory findings persist in the literature regarding the correlation between obesity and thyroid function [22]. A recent meta-analysis conducted by [23]. Comprising 22 studies, revealed a positive association between obesity and the risk of hypothyroidism. The study also highlighted a significant relationship between obesity and hypothyroidism, Hashimoto's thyroiditis, and peroxidase antibody. This implies that the prevention of obesity holds crucial importance in mitigating the risk of these thyroid disorders. However, the study did not document an association between obesity and hyperthyroidism.

The outcomes of the present investigation reveal a positive correlation between BMI and TSH, accompanied by a negative correlation with Triiodothyronine (T3) and Thyroxine (T4) levels. These findings are consistent with those of a cohort study undertaken by [24] in Denmark, which involved 4082 participants aged 18–65 and spanned an average follow-up duration of 5 years. Furthermore, [24] documented a positive relationship between serum TSH levels and BMI, alongside an observation that lower Free Thyroxine (FT4) concentrations were associated with elevated BMI Similarly, [25] conducted a cross-sectional investigation encompassing 3928 individuals in Spain, reporting a positive correlation between TSH levels and BMI. A study by [26] reported a controversial finding in a cohort study on 784 individuals in Spain; in contrast to most with our study, because this study reported a positive association between BMI, FT3, and FT4 after a 6-year follow-up. A cross-sectional study performed on 401 euthyroid individuals in Britain found no difference between obese and lean participants regarding TSH and FT4 levels; additionally, no association was found between BMI and TSH or FT4 [27].

5. CONCLUSION

Thyroid dysfunction increases with age and blood group O, no significant relationship between serum T3, T4, and BMI while there was a significant relationship between serum TSH and BMI and mean TSH increased as BMI increased. Further large-scale data from the population is required to confirm these findings.

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