Original Article

Thyroid Function Tests, Reverse T3 and Body Mass Index in Euthyroid Elderly.

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ABSTRACT
Background: With aging, marked changes in thyroid hormone production, metabolism, and action occur. Endocrine abnormalities are common in obesity, including altered thyroid function.
Objective: To assess the relation between thyroid hormones, reverse T3 and body mass index.
Patients and methods: A cross sectional study including 102 elderly patients (≥60 years) was conducted in Ain- Shams University hospitals. Weight, height, body mass index (BMI), thyroid hormones and reverse T3 were measured for all patients. Patients with thyroid dysfunctions were excluded from the study.
Results: BMI was not significantly related to reverse T3 or any of the measured thyroid hormone. Plot curves demonstrate a positive correlation between BMI and RT3, indicating that a rise in RT3 corresponds to an increase in body weight. Additionally, they reveal that RT3 decreases with underweight and increases with overweight, but these relationships are not statistically significant.
Conclusion: Thyroid function tests and body mass index are not significantly correlated.
Keywords: thyroid hormone, body mass index, elderly, reverse T3, metabolism.

INTRODUCTION

Thyroid hormones play key roles in growth and development. They are known to regulate the basal metabolic rate [1].

The obesity epidemic is a major threat to health in most countries. The international focus on obesity has led to a steep increase in the number of studies dealing with possible interactions between obesity and other diseases or physiology and pathophysiology of the various organs and tissues of the body.[2]

The relationship between obesity and the thyroid gland is complex and bidirectional. Thyroid dysfunction (hypothyroidism or hyperthyroidism) results in changes in body weight because of the participation of thyroid hormones in the control of thermogenesis and appetite. However, recent research has shown that excess weight can also influence thyroid function, with the presence of hyperthyrotropinemia, with or without changes in T3 and T4 concentrations, generally being observed in euthyroid obese subjects.[3]

Studies on the relation between weight and thyroid cancer showed a borderline positive association between the risk of cancer and body mass index (BMI). yet, it has been suggested that obesity may protect against thyroid nodules.[4]

Adiposity may be the consequence of the role of THs (or its metabolites) on the

regulation of metabolic rate, appetite control or even sympathetic activity. This sympathetic stimulus by THs also influences glucose and lipid metabolism as it impacts cardiovascular system regulation. [5]
Physiologically, there are age related changes in the concentration of thyroid hormone, in the form of reduced TSH, total T3 and free T3 levels, serum total and free T4 concentrations remain unchanged and increased rT3, which is an inactive T4 metabolite in the serum. [6]
The decreased peripheral hepatic metabolism of iodothyronine during aging by liver type I deiodinase (D1) can affect both serum T3 production and rT3 clearance. [7]
This study aimed to assess the relation between reverse T3, thyroid hormones and BMI in euthyroid elderly.

PATIENTS AND METHODS

Study design: A cross-sectional single-center study.
Study sample: Sample size calculation was done. A total of 102 subjects (both males and females) aged 60 years or above were recruited for the study.
Study setting: The participants were recruited from the outpatient clinics of Ain Shams University Hospitals. Patients with hypo- or hyper-thyroidism were excluded from the study, that were based on previous thyroid functions and symptoms of hypo- or hyper-thyroidism.
Methodology: Socio-demographic and medical characteristics were assessed in all participants. Data regarding weight, height and BMI were taken. Measurements of TSH, total triiodothyronine(T3), total thyroxine (T4), free T3, free T4 and reverse T3 (rT3) were done. Blood samples were collected in the morning after an overnight fast. TSH was measured using an immunometric technique. T4, T3, and rT3 were all measured using enzyme immunoassay.
Subclinical hypo- and hyperthyroidism were defined as free T4 (FT4) levels within the normal range (between 11 and 25 pmol/liter) and TSH levels above or below normal range (0.4- 4.3 mU/liter)
Data analyses: Results were expressed, unless otherwise stated, as mean and standard deviation. Variables, which were not normally distributed, were logarithmically transformed. Comparisons between groups were made by using ANOVA.
Differences are given with corresponding 95% confidence intervals (CIs). Relations between variables were assessed using linear regression stated as linear regression coefficient (beta) and 95% CI. Multiple regression analysis was used to adjust for age and body mass index and determine the contribution of different independent variables to the dependent variable.
Univariate general linear model was used to determine the significance between groups and adjust for covariates. Unless otherwise mentioned, all analyses are done after adjustment for age.
Ethical Considerations: An approval for the study was granted before starting the subject's recruitment process. The approval was obtained from the ethics committee in Ain Shams Faculty of Medicine.
Explaining the purpose of the study and assuring the confidentiality of all participants, a written informed consent was obtained from the participant or a responsible proxy.

RESULTS

Females constituted 59.8% of the studied sample and the mean age of the study group was 74.02 ± 7.94 years.
By categorizing the study sample according to BMI, it was found that neither age nor smoking were significantly different between the study groups. BMI was

significantly lower in the males compared to females. **(Table 1)**

As for medical characteristics, hypertension, liver and renal diseases and rheumatoid arthritis were significantly associated with BMI in the study sample. Only diabetes mellitus (DM) had significantly higher BMI. **(Table 2)**

The IQR of each of the studied thyroid markers and BMI distribution in the different groups are displayed in **(Table 3)** **(Figure 1-2)**

There was no statistically significant correlation between BMI and any of thyroid hormones or RT3 within the whole study group. **(Table 4)**.

Plot curves shows that there is a positive association pattern between BMI and RT3 as when RT3 increase the body weight increase, and it shows that RT3 decrease with underweight and increase with overweight but it was not statistically significant **Figure (3-5).**

DISCUSSION

This cross-sectional study was conducted on 102 elderly participants with no thyroid illness attending the hospital to assess the relation between RT3, thyroid function tests and BMI.

Prior studies [8] showed that gender is associated with socioeconomic patterning of BMI. BMI increased over time in almost all age groups. Smoking and age were yieled contradictory results. In this study, we did not find a statistically significant association between BMI and age or smoking but males had significantly lower BMI.

The relation between BMI and comorbidities had been extensively studied in research among different age groups. The prevalence rates of hypertension, gallstone, urinary tract calculus, diabetes and cerebrovascular diseases were found higher in obese men.[9] Other studies found that comorbidities were not associated with BMI or even protective among elderly.[10] Our study shows that no statistical significance between BMI and HTN, liver disease, renal disease and rheumatic disease but there is significance between BMI and DM, however in previous study revealed.

Features of aging are in part similar to those of hypothyroidism. In both conditions basal metabolic rate decreases.[11] There is important interaction exists between thyroid function, weight control, and obesity. Several mechanisms seem to be involved, and in studies of groups of people the pattern of thyroid function tests depends on the balance of obesity and underlying thyroid disease. Many patients treated for hyperthyroidism experience a gain of more weight than they lost during the active phase of the disease. The mechanism for this excessive weight gain has not been fully elucidated.

The current study attempted to examine the relation between thyroid hormones and BMI in elderly. The mean weight was 73.99 ± 15.44, the mean height 164.26 ± 6.22, accordingly BMI was classified into underweight, normal, overweight with median of 15, 22, 29 respectively. For the distribution of BMI **Rumaropen et al**. found Weight (kg) 56.53 ± 9.95, Height (cm) 157.33 ± 6.423 also classified it into: Underweight 4 (11.1%), Normal 19 (52.8%), Overweight 7 (19.4), Obesity 6 (16.7%) and the difference could be contributed by the fact that our study population was taller and that obesity is more common in Egyptians.[12]

For the thyroid function tests, the IQR of TSH was 1.71 (1.12 - 2.6), FT3 2 (1.58 - 2.36), T3 2.95 (0.97 - 3.9), FT4 1.45 (1.22 - 1.63), T4 12.55 (10.15 - 14.4), RT3 888.65 (589.4 - 1500). In Waring et al. study the majority of the participants (84%) had euthyroid conditions. Subclinical hyperthyroidism affected 2% (n = 50), overt hypothyroidism affected less than 1% (n =

21), and subclinical hypothyroidism affected nearly 13% (n = 268).[13]

Our study found no statistically significant correlation between BMI and any parameter of thyroid function tests nor RT3 within the whole study group. Yet, a positive association pattern between BMI and RT3 as when RT3 increase the body weight increase, and it shows that RT3 decrease with underweight and increase with overweight but it was not statistically significant.

In comparison to our study, most studies have found increased TSH levels in patients with morbid obesity. [14] Increased FT4 in obesity has been found in some studies, [15] and others found no significant change in FT4 or FT3 levels with weight.[16]

Conclusion: There is a positive association pattern between BMI and RT3 as when RT3 increase the body weight increase, and it shows that RT3 decrease with underweight and increase with overweight but it was not statistically significant.

Conflict of interest: The Authors declared no conflict of interest.

Contributions to the work: All authors contributed equally to the work.

Table 1: Relation between body mass index and demographic data.

		BMI interpretation			**Test of significance**		
		Underweight (N= 4)	**Normal (N= 31)**	**Overweight (N= 67)**			
Age		Mean ± SD N (%)	Mean ± SD N (%)	Mean ± SD N (%)	Value	P-value	Sig.
		76.5 ± 10.08	76.29 ± 7.86	72.82 ± 7.72	*f*= 2.281	0.107	NS
		No. (%)	**No. (%)**	**No. (%)**			
Gender	**Female**	1 (25%) ^{a,b}	13 (41.94%) ^{b}	47 (70.15%) ^{a}	FE	**0.008**	**S**
	Male	3 (75%) ^{a,b}	18 (58.06%) ^{b}	20 (29.85%) ^{a}			
Smoking	**No**	3 (75%)	23 (74.19%)	61 (91.04%)	FE	0.058	NS
	Yes	1 (25%)	8 (25.81%)	6 (8.96%)			

*One Way ANOVA test of significance formula (f= the mean square of the between group divided by the mean square of the within group);*Fisher's Exact test of significance;* Every subscript letter represents a subset of group categories whose column proportions at the 0.05 do not differ noticeably from one another.

Table 2: Relation between different groups of BMI and medical characteristics within the whole group.

		BMI interpretation			Fisher's Exact test	
		Underweight (N= 4)	Normal (N= 31)	Overweight (N= 67)		
		N (%)	N (%)	N (%)	P-value	Sig.
HTN	No	2 (50%)	11 (35.48%)	12 (17.91%)	0.054	NS
	Yes	2 (50%)	20 (64.52%)	55 (82.09%)		
DM	No	4 (100%) [a]	22 (70.97%) [a]	33 (49.25%) [b]	**0.023**	**S**
	Yes	0 (0%) [a]	9 (29.03%) [a]	34 (50.75%) [b]		
Liver disease	No	4 (100%)	31 (100%)	66 (98.51%)	1.00	NS
	Yes	0 (0%)	0 (0%)	1 (1.49%)		
Renal disease	No	4 (100%)	19 (61.29%)	40 (59.7%)	0.399	NS
	Yes	0 (0%)	12 (38.71%)	27 (40.3%)		
Rheumatoid arthritis	No	4 (100%)	31 (100%)	66 (98.51%)	1.00	NS
	Yes	0 (0%)	0 (0%)	1 (1.49%)		

** Every subscript letter represents a subset of group categories whose column proportions at the 0.05 do not differ noticeably from one another.*

Table 3: Distribution of BMI, thyroid hormones and RT3 in the study sample.

Total study sample (N=102)	
Median (IQR)	
Underweight (N= 4)	15 (14-17)
Normal (N= 31)	22 (19-24)
Overweight (N= 67)	29 (25-53)
TSH	1.71 (1.12 - 2.6)
FT3	2 (1.58 - 2.36)
TT3	2.95 (0.97 - 3.9)
FT4	1.45 (1.22 - 1.63)
TT4	12.55 (10.15 - 14.4)
RT3	888.65 (589.4 - 1500)

Table 4: Correlation between BMI, RT3 and thyroid function tests within study group.

	BMI interpretation			Kruskal Wallis test		
	Underweight (N= 4)	**Normal (N= 31)**	**Overweight (N= 67)**			
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**H**	**P-value**	**Sig.**
TSH	2.04 (1.72 - 2.3)	1.53 (1 - 2.55)	1.77 (1.12 - 2.98)	0.520	0.771	NS
FT3	2.39 (1.98 - 3.05)	1.7 (1.5 - 2.27)	2 (1.6 - 2.36)	4.922	0.085	NS
T3	0.88 (0.56 - 1.65)	2.6 (0.91 - 3.8)	3.09 (1.2 - 4)	4.836	0.089	NS
FT4	1.68 (1.35 - 2.3)	1.43 (1.22 - 1.6)	1.45 (1.2 - 1.65)	1.787	0.409	NS
T4	11.8 (8.55 - 14.6)	12.5 (10.1 - 14)	12.8 (10.3 - 14.5)	0.292	0.864	NS
RT3	861.65 (719.45 - 1928.5)	780 (578.2 - 1350)	927 (573.4 - 1523)	0.413	0.813	NS

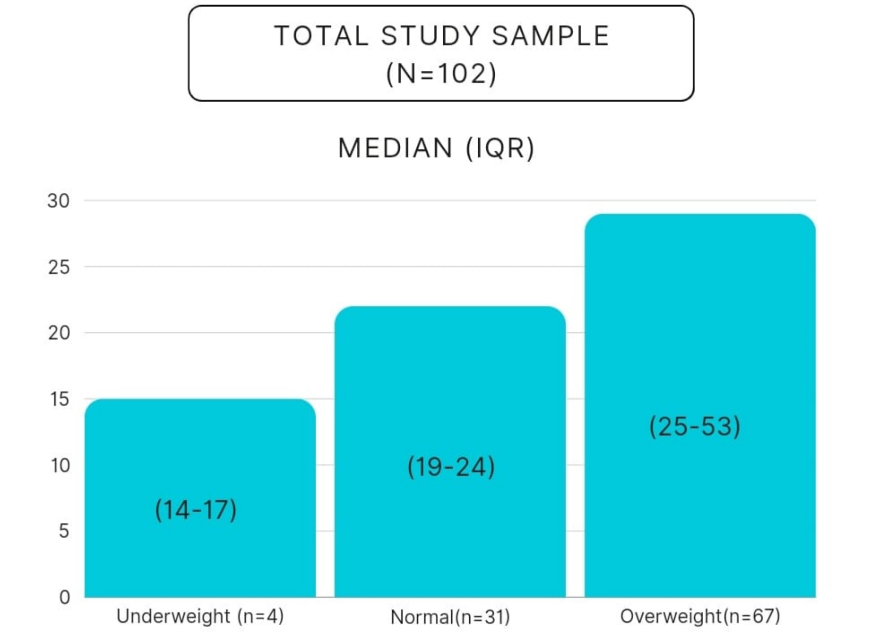

Figure (1): Distribution of BMI in study sample

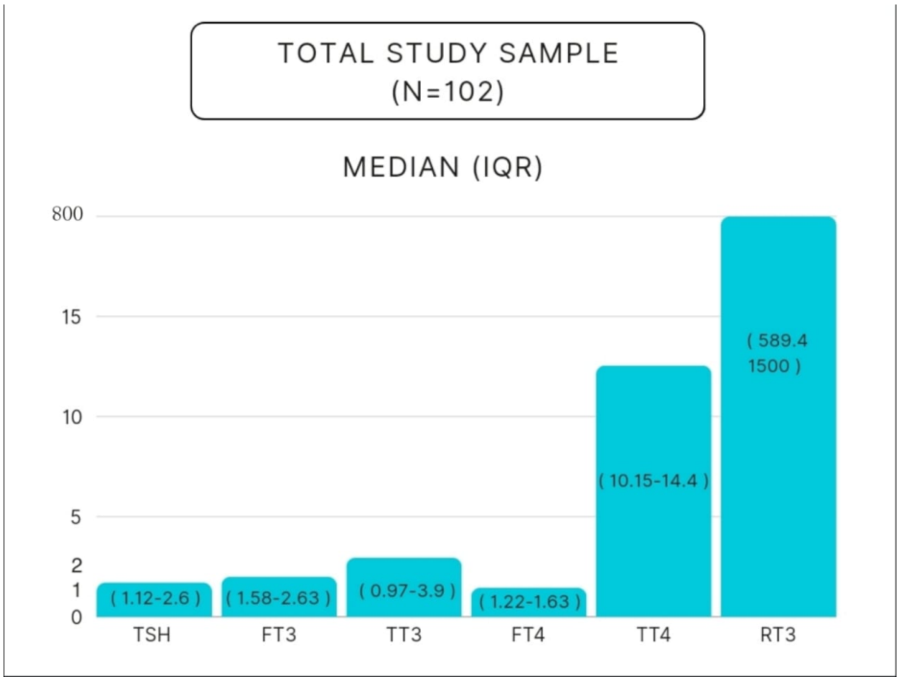

Figure (2): discribution of thyroid hormone and RT3 in study sample

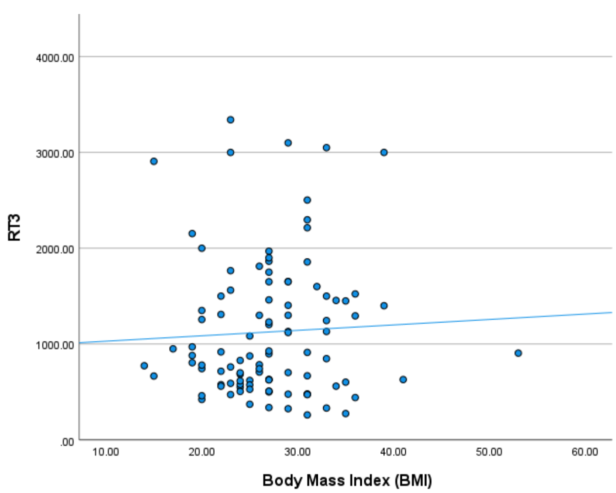

Figure (3): Correlation between BMI and RT3 within the whole study group.

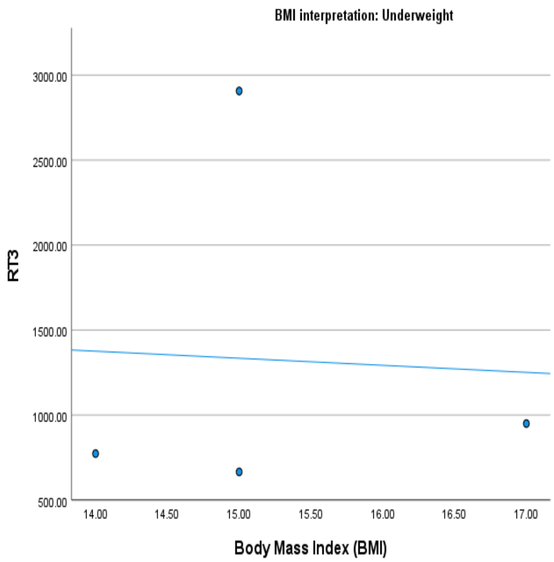

Figure (4): Correlation between BMI and RT3 within underweight group.

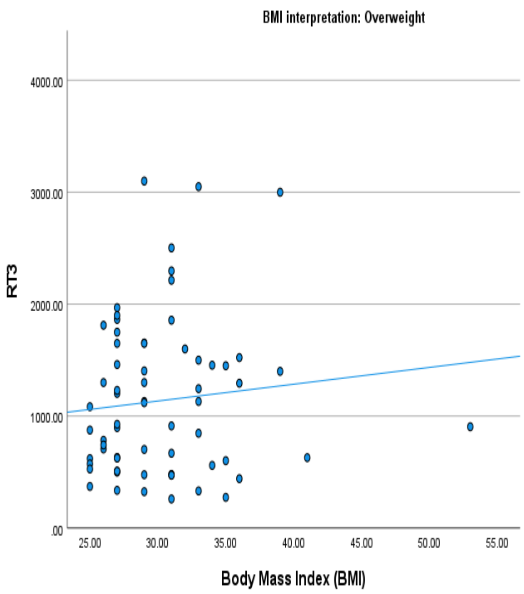

Figure (5): Correlation between BMI and RT3 within overweight group.

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