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Relationship Between Body Mass Index (BMI), Body Fat Percent And Serum TSH Level In Eu-Thyroid Female Subjects

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Abstract:
Objective: To investigate whether there is an association between Body Mass Index (BMI), Body fat percent and serum Thyroid stimulating hormone (TSH) in eu-thyroid female subjects.
Methods: 103 randomly selected eu-thyroid female subjects were included in this study. Their BMI was estimated by Metric method, Body fat percent was measured by Harpenden skin fold caliper. Serum TSH was measured from fasting serum sample by Enzyme-linked-immuno-sorbant (ELISA) Assay.
Results: A positive linear association was found between BMI and serum TSH level ($r=0.342$, $p<0.002$). Body fat percent of eu-thyroid female subjects also showed strong positive linear correlation with serum TSH level ($r=0.628$, $p<0.000$). . There is gradual increase in serum TSH values among three BMI groups i.e normal weight (BMI <23 kg/m^2), over-weight (BMI 23.00-24.99 kg/m^2), and obese (BMI >25 kg/m^2) females.
Conclusion: Serum TSH level increases with increase in fat content of the body. Obese women shows higher serum TSH level even if the upper limit of TSH is within normal limit.

Keyword: *BMI, Body fat percent, Serum TSH, Eu-thyroid female*
Running Title*: BMI, Body fat percent and serum TSH association in eu-thyroid females*

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I. Introduction

Thyroid hormone plays an important role in thermogenesis and influences all major metabolic pathways such as protein, carbohydrate and lipid metabolism. It affects body weight through modification of basal metabolic rate. Overt hypo-thyroidism is associated with weight gain; weight loss is a common symptom in patients with overt hyper-thyroidism. (1)

Recent reports suggested that some cytokines exclusively secreted by adypocites, such as leptin and also adiponectin, could be correlated with thyroid function. In fact, the regulation of Thyrotropin releasing hormone (TRH) gene expression in the para-ventricular nucleus of the hypothalamus by leptin has been reported to be critical for normal function of the thyroid axis in humans. (2)

Obesity is associated with altered thyroid function (3), but the range of hormonal changes related to weight gain remains a subject of debate. Among the several hormonal changes that occur in obesity, serum TSH concentration has been the focus of recent studies with conflicting results. The potential impact of minor changes in thyroid function on body weight and other anthropometric measures, especially in euthyroid subjects (4–6), has been investigated. But, the definition of the upper limit of normal serum TSH range has been under intense debate in the literature (7, 8). It has been suggested that the upper limit of the normal serum TSH range be reduced to 2.5 mU/l (8), but a large epidemiologic study in a population with no evidence of thyroid disease, seronegative for thyroid autoantibodies, without history of thyroid medications, and normal on thyroid ultrasound, indicated a serum TSH value of 4.0 mU/l as the upper reference limit (7).There are fewer studies focusing specifically on the association between changes in anthropometric measures and serum TSH concentration among subjects with normal thyroid function or subclinical thyroid disease.

The present endeavor is an attempt to evaluate the association of Body Mass Index (BMI) and percent of body fat of eu-thyroid women with their serum Thyroid stimulating hormone (TSH) level. A further attempt was made to sort an idea how serum TSH level changes in normal weight, over-weight and obese females having their thyroid profile within normal range.

II. Material and Methods

This descriptive cross-sectional study was carried out at B. S. Medical College, Bankura, West Bengal, over a period of six months (January 2012-July 2012). Institutional ethical committee clearance and informed consent from all the subjects were obtained.

All the eu-thyroid female subjects attending Biochemistry department for testing their Thyroid profile during the study period were included in this study provided they have fulfilled the following inclusion criteria. Inclusion criteria for the subjects were:

- No significant clinical abnormalities on physical examination
- No history of intake of lipid-lowering, hypoglycemic, antihypertensive drugs
- No history of Cardiovascular or respiratory disease
- Normal ECG (Electrocardiogram)
- Normal Fasting blood sugar level (<6-10 m mol/l)
- Normal Systolic blood pressure (<130mmHg)
- Normal Diastolic blood pressure (<85 mmHg) for at least three measurement

A total of 103 eu-thyroid female subjects (i.e TSH level within 0.4 µIU/ml to 3µIU/ml) (9) who fulfilled the study criteria were included in the study. Body Mass Index and Body fat percent were measured in these subjects. Body Mass Index was estimated by Metric method. (10) The standing height of the subjects was measured with the same stadiometer, without footwear; to the nearest centimeter. Weight was measured, which was the nearest to 0.1 kg, with the subjects in the standing position, before lunch, with light clothes and without footwear, by using a standardized weighing scale [11].Depending on their BMI values, the subjects were classified into three groups. The subjects with a BMI value of less than 23 was be classified as normal weight, subjects with a BMI value between 23 to 24.99 [Kg/M2] was classified as the overweight group and those who have a BMI value more than 25 [Kg/M2] was classified as obese [12]

Harpenden Skin fold Caliper was used to measure percent of body fat. The four site system was used in female subjects. Site 1-Biceps, Site 2- Triceps, Site 3- Sub-scapular, Site 4- Supra-iliac. To calculate % Body fat linear regression equations of Durnin and Wormersley was used. (11)

Body Density= C [M (log10 Sum of all four skin folds)]

MALE	17-19 YRS	20-29 YRS	30-39YRS	40-49 YRS	50+ YRS
C	1.1620	11631	1.1422	1.1620	1.1715
M	0.0630	0.0632	0.0544	0.0700	0.0779

FEMALE	16-19 YRS	20-29 YRS	30-39YRS	40-49 YRS	50+ YRS
C	1.1549	1.1599	1.1423	1.1333	1.1339
M	0.0678	0.0717	0.0632	0.0612	0.0645

Fat %= [(4.95/Body Density)-4.5]*100

Serum TSH was estimated by Enzyme-linked-immuno-sorbant assay (ELISA). Five ml of cord blood samples were collected from the peripheral veins in sterile test tubes. The serum separated by centrifugation was used for quantitative estimation of TSH, Total T3, Total T4 by a micro plate immuno-enzymatic assay. (Ranbaxy) The intra and inter-assay coefficient of variation (CV) for TSH estimation were 4.33% and 7.5% respectively and the sensitivity limit was 0.078 µ IU/ml. That for total T3 was 5.73% and 6.7% respectively with the sensitivity limit 0.04 ng/ml and total T4 were 4.7% and 5.4% respectively with the sensitivity limit 0.4 µg/dl.

The collected data was analyzed with SPSS (version 18) statistical package using Pearson's correlation test.

The study population were further subdivided into three groups Normal weight (BMI<23 kg/m^2), Over-weight (BMI 23.00-24.99 kg/m^2) and obese (BMI>25 kg/m^2) in accordance with their BMI. Analysis of Variance (ANOVA) Test among the above three groups was done to see the changes of TSH level with increasing body mass index.

III. Results

A total of 103 eu-thyroid female subjects were included in the study. Their mean age was 56 years (Range 30-82).A positive linear correlation was observed between BMI and serum TSH in eu-thyroid female subjects (95% CI, p <.002, r=0.342) (Table 1). Body fat percentage and serum TSH level of eu-thyroid female subjects were also been found to have strong positive linear correlation (95% CI, p <.000, r=0.851) (Table 1). Figure 1 and 2 depict the linear association between BMI-TSH and Body fat percentage-TSH respectively.

There are significant inter-group variations among BMI and serum TSH concentration (Table 2). Figure 3 depicts the gradual increase in serum TSH values among three BMI groups i.e normal weight, over-weight and obese.

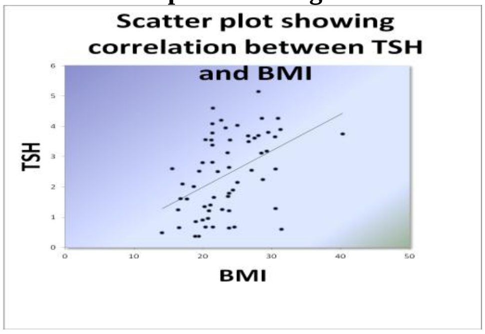
Table 1: The association between BMI, Body Fat Percent and serum TSH in eu-thyroid female subjects

		BMI(kg/M^2)	**% Body Fat**
TSH (µ IU/ml)	Pearson Correlation (r)	**0.342*****	**0.628*****
	Sig. (2 tailed)	<0.002	0.000
	N	103	103

Table 2: Serum TSH concentration in Normal weight, Over-weight and Obese eu-thyroid females

BMI (kg/M^2)	N	TSH(µ IU/ml) Mean± S.D	Calculated F ratio	Significance
<23 (normal weight)	79	1.99±1.49	6.176	0.003**
23.00-24.99 (over-weight)	8	3.30±2.78		
>25.00 (obese)	16	3.28±2.29		

Figure 1 & 2: Scatter plots showing linear relationship between TSH-BMI and TSH-Body fat percentage



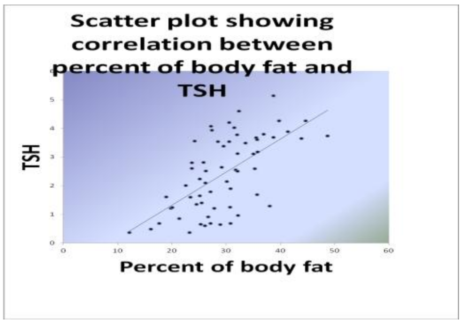
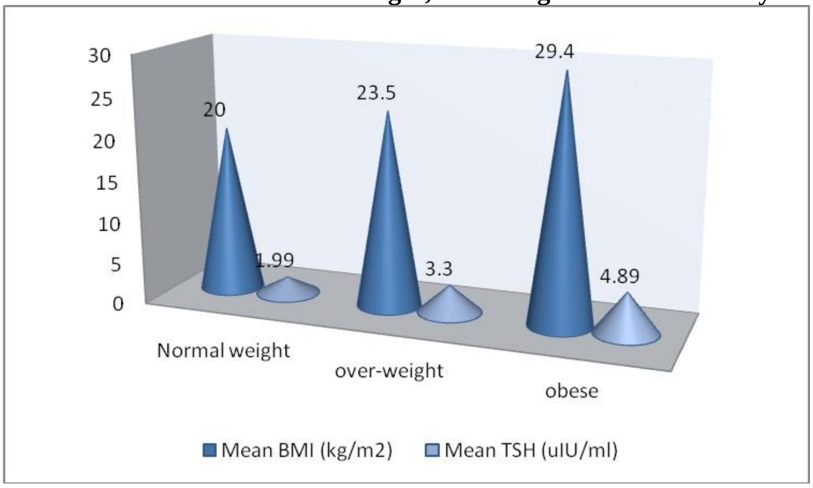


Figure 3: Serum TSH values in normal weight, over-weight and obese eu-thyroid females



IV. Discussion

In the present study, we have found that although in the normal range, serum TSH is positively associated with BMI and body fat percent in eu-thyroid female subjects. Furthermore, there are significant inter-group variations among BMI and TSH concentration. Serum TSH values gradually increases among three BMI groups i.e normal weight, over-weight and obese. As TSH and BMI could both be affected by a third factor, which according to our observation may be age, we included age as an independent variable in multiple regression analysis. We found the association between age and BMI above the age 50, in which age group BMI starts falling with age in male and remains unaffected in female. Hence age is unlikely to be the cause of association between TSH and BMI.

There are agreements for a causal relationship between TSH and BMI in few previous studies. Our observation is in accordance with those of A Nymes et al who found serum TSH is positively associated with BMI especially among non-smokers. Mehmet Bastemir et al also found a positive association of BMI with serum TSH level, independent of thyroid function. Although one study report by S. Yardemei et al found alteration in serum T3, T4 and TSH level in normal ranges did not affect the body fat percentage, fat distribution and lean body mass in elderly women.

Although physiologically elevated TSH is likely to be associated with decreased lipid stores and increased lipolysis in adipose tissue but the contradictory evidence of serum TSH levels, positively correlated with BMI can be explained by leptin. Free T4 at lower limit of normal range and elevated serum TSH although in a normal range is seen in sub-clinical hypothyroidism. This may cause alteration of energy expenditure with subsequent rise in BMI and body weight. This increased fat mass may increase leptin. And it is already known that leptin is an important neuro-endocrine regulator of the Hypothalamo-Pituitary- Thyroid axis () by regulation of TRH gene expression in para-ventricular nucleus. Hence it further rises TSH.

The present study has few limitations. Ours is cross-sectional study and we have not measured free T4 and free T3 level. A longitudinal study with more sample size is required to see the hormonal pattern and concentration of leptin in same patient with progressive weight loss or gain.

In conclusion, this study shows a positive and significant association between serum TSH within normal range and BM. Furthermore, there are significant inter-group variations among BMI and TSH concentration. Serum TSH values gradually increases among three BMI groups i.e. normal weight, over-weight and obese. Future research work with more sample size is necessary to see the impact of body fat and body fat distribution on the alternate of thyroid function.

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