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Original Research Article

Correlation between Thyroid Function Tests and Body Mass Index in Young and Middle Age Euthyroid Population

Suhail Ahmad[1], Shayees Arawa[2]

[1]Professor, Postgraduate Department of Physiology, Government Medical College Srinagar, Srinagar, Jammu and Kashmir, India

[2]Senior Resident, Postgraduate Department of Physiology, Government Medical College Srinagar, Srinagar, Jammu and Kashmir, India

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Corresponding author: Dr. Shayees Arawa

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Abstract

Purpose: The relationship between thyroid function tests and body mass index has been a topic of debate among researchers. While it is known that abnormal thyroid function can affect weight, it is not clear whether there is an association between thyroid function and body mass index in individuals with normal thyroid function (euthyroid). This study aimed to determine the correlation between thyroid function tests and body mass index in young and middle age euthyroid subjects.

Methods: The study included 400 individuals (178 males and 222 females) who were euthyroid with ages ranging from 20 to 60 years. After conducting a clinical examination and obtaining written informed consent, blood samples were collected and analyzed for thyroid function tests. The BMI was calculated, and the values were examined for any potential associations.

Results: We found that the mean values of serum T3 and T4 did not show any significant difference among normal weight, overweight, and obese subjects. However, TSH levels were not significant for normal weight and overweight, but we observed a statistically significant difference in the mean TSH values between normal weight and obese subjects. This means that individuals who are obese have higher TSH values than normal-weight individuals.

Conclusion: It is worth noting that our findings indicate that only TSH had a positive correlation with BMI. Interestingly, T3 and T4 did not seem to have any significant correlation with BMI. These results suggest that TSH could be a valuable marker for predicting BMI changes.

Keywords: T3, T4, TSH, BMI, Thyroid Function Tests, Euthyroid.

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Introduction

The thyroid is an important endocrine gland that produces hormones that affect various body systems. The hypothalamus releases thyrotropin-releasing hormone (TRH), which stimulates the anterior pituitary gland to release thyroid-stimulating hormone (TSH). TSH then binds to receptors on the thyroid follicular cells, triggering a series of events that result in the synthesis of thyroid hormones [1].

Beside regulation of energy levels, body temperature, brain development, health of muscles and bones, thyroid hormones has a major effect on the body's metabolism[2].The three main hormones secreted by the thyroid gland are triiodothyronine (T3), thyroxine (T4), and calcitonin. T3 is formed in a smaller amount but is more active than T4, which is formed in a larger amount [3].Body mass index (BMI) is an indication of an individual's fatness. It is used to define anthropometric height and weight features in humans and classify them into groups of underweight, healthy weight, and overweight. It is also used as an indicator of risk factors for several diseases and thus helps in determining various health policies [4].

Thyroid hormones play a significant role in adaptive thermogenesis, and alterations in their levels can lead not only to obesity but are also associated with changes in body mass index, which means that they can influence both body mass and body fat [5]. Genetic and environmental factors, of which iodine intake level seems to be of major importance, can result in small variations in serum thyroid levels between individuals also within the normal range. These small variations in thyroid function tests present a risk for an increase in body weight and the development of obesity. [6].Overweight is a major threat to public health, with obesity presenting as an epidemic in the present modern world [7].Overt hyperthyroidism and hypothyroidism are associated with changes in weight and body composition. However, it is uncertain whether there is a significant relationship between thyroids function and body mass index (BMI) in euthyroid subjects.

Material & Methods

This study aimed to investigate the relationship between thyroid function tests and body mass index (BMI) in young and adult populations. The study included 400 healthy subjects of both sexes, aged between 20 and 60 years. The subjects were selected from various sources, such as students from Government Medical College Srinagar and Government Dental College Srinagar, technical and non-technical staff of the physiology department, hospital employees under the jurisdiction of Government Medical College and Government Dental College Srinagar, and other healthy volunteers from different sections of society.

A thorough medical history was taken, and a general physical examination, as well as a systemic clinical examination, were done to exclude subjects known to suffer from any significant non-thyroidal illness or any thyroid-related illness. On a detailed clinical examination, only those subjects were selected who were ambulatory, in a normal nutritional state, and without any abnormalities. History of any thyroid disorder in the past was ruled out. Thus the study participants had no prior history of thyroid disorders, were not taking any medications that may affect thyroid hormone measurements, and were not receiving any institutional care.

The subjects were classified into two groups according to their age:

- Group A : 20-39 years
- Group B : 40-60 years

Blood Sampling: After obtaining their consent, blood samples were taken from selected subjects in a non-fasting state because fasting causes a rapid fall in system T3 concentration [8]. Blood samples were collected after taking all necessary aseptic precautions. About 4 ml of blood was drawn from the anterior cubital vein in the cubital fossa and collected in a vaccutainer. The collected sample was then allowed to stand undisturbed at room temperature for approximately 2 hours. Following this, the blood sample was centrifuged at 3000 rpm for about 5 minutes, which helped in the quick separation of serum. The separated serum was then poured into sample cups that were fitted into adaptors on the 'analyzer'. The adaptors were numbered, and sample ordering was done. Selective keys on the 'auto analyzer' were then used to feed the required information, and the samples were auto-analysed by the "Elecsys 1010 auto-analyzer. This is a fully automatic, run-oriented analyzer system for determining immunological tests using the ECL (Electro chemi-luminescent process).

The principle applied for estimation of serum T3, T4 and TSH levels In “Roche Elecsys 1010 Analyzer “is called as” “Sandwich Principle”, which uses Electro chemi luminescence immune assay “ECLIA”. It is considered to be highly sensitive method for estimation of T3, T4 and TSH levels (Harrison’s principle of internal medicine 16th Ed., Joseph G, Hallowell et al-2002, Cecil’s textbook of Medicine – 16thEd.).

Anthropometrical Measurement: All the participants were subjected to physical examination including the following.

- Height: The height of an individual, participant of the study was measured, by a stadiometer without shoes in height square (m^2).
- Weight: The weight of participants was measured by a digital weighing machine in kilograms (kg).
- BMI: BMI of the subjects was calculated as body weight (kg) divided by height squared (m^2) while they were barefoot and wearing light clothes.

Results

Table 1: Distribution of Age (Years), Weight (Kgs), Height (Cms) and Body mass Index (Bmi) of the Study Subjects

Variable	Range	Mean±S.D
Age (years)	20-60	37.65±13.97
Weight(kgs)	40-85	59.36±9.62
Height (cms)	141-183	163±9.43
BMI (kg/m^2)	16.16-37.72	22.51±4.08

Table 2: Comparison of Age (Years) and Sex of the Study Subjects

Age (Years)	No. of Cases	Male	Female		P-Value
20-30	226	102 (45.10 %)	124(54.90%)	x^2=0.084 1.d.f	0.772 (Non-Significant)
40-60	174	76(43.70%)	98 (56.30%)		
Total	400	178(44.5%)	222(55.5%)		

Table 3: Age and Sex Distribution of Study Subjects

Age in Years	No. of cases	Male	Female
20-39	226	102 (45.10 %)	124 (54.90%)
40-60	174	76 (43.70 %)	98 (56.30%)
Total	400	178 (44.5%)	222 (55.5 %)

Table 4: Comparison of T3 Values (µg/dL) with Respect to Body Mass Index

BMI	No. of Cases	Mean±SD	T-Value	P-Value	Result
Group-I (≤ 25)	304	0.97±0.19	I vs II=1.82	0.078	Non – Significant
Group-II (25.1-29.9)	76	0.94±0.13	II vs III=1.14	0.190	Non – Significant
Group-III (≥30)	20	0.95±0.15	I vs III=1.81	0.076	Non – Significant

Table 5: Comparison of T4 Values (µg/dl) with Respect to Body Mass Index

BMI	No. of Cases	Mean±SD	T-Value	P-Value	Result
Group-I (≤ 25)	304	8.47±1.84	I vs II=0.98	0.330	Non – Significant
Group-II (25.1-29.9)	76	8.26±1.51	I, II vs III=0.48	0.659	Non – Significant
Group-III (≥30)	20	8.16±1.68	I vs III=0.69	0.490	Non – Significant

Table 6: Comparison of TSH Values (µIU/ml) with Respect to Body Mass Index

BMI	No. of Cases	Mean±SD	T-Value	P-Value	Result
Group-I (≤ 25)	304	2.26±0.96	I vs II=0.91	0.367	Non – Significant
Group-II (25.1-29.9)	76	2.38±0.97	I, II vs III=0.95	0.344	Non – Significant
Group-III (≥30)	20	2.67±0.96	I vs III=2.36	0.021	Significant

The study involved 400 individuals aged between 20 and 60, who were all able to walk and in good health. A thorough clinical examination was conducted to exclude any thyroid disorders or other illnesses that could affect thyroid function, both past and present. The subjects were then divided into two groups.

- Group' A' consisting of young adults (both male and female) each aged 20-39 years end
- Group 'B' consisting of middle-aged (both male and female) aged 40 to 60 years.

Blood samples were collected from all the subjects through venous blood after obtaining proper consent. It was ensured that all the subjects were in a non-fasting state during the collection process, as fasting tends to cause a rapid fall in serum T3 concentration. (Palmblad et al, 1977).The serum collected from these samples were analysed on "Elecsys 1010 auto analyzer" which uses non-competitive immunometric assay method by using chemiluminescent molecules as signals.

The statistical analysis of the data collected was done by using the test statics chi-square test (x^2 – test) and student's t- test for differences of means. These tests were referred for p-values for their significance. Any p-value less than 0.05 i.e ($P < 0.05$) was taken to be significant. The analysis of the data was done by using statistical package "SPSS version 10.0 Chicago, USA for Windows.

The study involved volunteers aged between 20 and 60 years. Their average age was 37.65 ± 13.97 years. The weight of the volunteers ranged from 40 to 85 kgs, with an average weight of 59.36 ± 9.62 kgs. The height of the volunteers varied from 141 to 183 centimetres, with an average height of 163 ± 9.43 centimetres. The body mass index (BMI) of the subjects was also calculated. The minimum BMI was 16.16 and the maximum was 37.72, with an average of 22.51 ± 4. 08.(Table 1)

In Group A i.e subjects aged 20-39 years there were 102 (45.10%) males and 124 (54.90%) females while in Group B i.e subjects aged 40-60 years, there were 76 (43.70%) males and 98 (56.30%) females. The distribution of sex with respect to two different age groups was non-significant. (Table 2)

The total number of cases studied were divided into three groups according to their BMI viz.

- Group I - BMI ≤ 25 (Normal weight)
- Group II - BMI 25.1 - 29.9 (Over weight)
- Group III - BMI ≥ 30 (Obese)

In the study, the mean T3 value was measured in three different groups based on BMI. Group I had a BMI of 25 or lower, Group II had a BMI between 25.1 and 29.9, and Group III had a BMI of 30 or higher. The mean T3 value in Group I was 0.97 ± 0.19 ng/ml, in Group II was 0.94 ± 0.13 ng/ml, and in Group III was 0.95 ± 0.15 ng/ml. However, the difference in T3 values in all three groups with respect to BMI was not found to be statistically significant, as shown in Table 4. In the study, the mean T4 value for Group I (BMI ≤ 25) was 8.47 ± 1.84 µg/dl, for Group II (BMI 25.1 - 29.9) it was 8.26±1.51 µg/dl, and for Group III (BMI ≥30) it was 8.16 ± 1.68 µg/dl. The difference in T4 levels across all three groups, based on their BMI, was found to be statistically non-significant, as indicated in Table 5.

The mean TSH value was measured in three groups based on BMI. In Group I (BMI ≤ 25), the mean TSH value was 2.26 ± 0.96 µIU/ml. In Group II (BMI 25.1-29.9), the mean TSH value was 2.38 ± 0.97 µIU/ml. In Group III (BMI ≥ 30), the mean TSH value was 2.67 ± 0.96 µIU/ml. The difference in TSH value between Group I and Group II was not statistically significant. Similarly, the difference in TSH values between Group II and Group III was not statistically significant. However, the TSH value was significantly higher in Group III (BMI≥ 30) compared to Group I (BMI ≤ 25). This difference was statistically significant (Table 6).

Discussion

T3, T4, and TSH levels are one of the basic investigations for the evaluation of the thyroid gland and also form the first line of investigations among various thyroid function tests. The relationship between thyroid function and the body mass index is interesting. Various studies have demonstrated the effect of thyroid hormone on body mass index, and the results have shown that body weight has an influence of overt thyroid dysfunction [9]. Results of some studies have shown that small variations exist in thyroid function tests even when they are within the normal range, and these small variations implicate their effect on body weight and thus on the prevalence of obesity[10]. Various studies have concluded that weight gain is attributed to different variations in thyroid function, even in euthyroid subjects [11,12].

Several studies have suggested that the homeostasis of thyroid hormone may be disturbed by adipose tissue dysfunction [13]. As leptin is produced and secreted by the adipose tissues so the patients who are obese must have higher leptin levels and it is this leptin that interacts with the thyroid hormone and affects the rhythm of the TSH secretion. Leptin can also inhibit iodine uptake and NIS gene expression and thus result in the suppression of thyroid hormone [14].

Obesity has been recognised as a world epidemic [15] as it is a chronic, inflammatory condition in which several inflammatory markers, e.g., WBC, neutrophil, and lymphocyte count, are raised. Some of the studies have found these markers also play some role in the development of nodular thyroid disease [16,17,18]. Xu et al. conducted a study and found that thyroid function could influence body weight and contribute to the development of obesity [19]. The relation between BMI and thyroid function tests was of great interest, as different researchers had different conclusions about it that prompted us to undertake this study.

The primary objective of this study was to establish a correlation between thyroid function tests and body mass index in normal euthyroid subjects of young and middle-aged subjects. This study was conducted over 400 euthyroid young and adult subjects with ages ranging from 20 to 60 years. We found that the values of T3 and T4 were statistically not significantly related to BMI. The finding by Knudsen et al also suggests no relation between T3 and BMI [20]. However, this was contrary to the finding by Reinehr et al., who concluded that peripheral thyroid hormones (T3, T4) are moderately increased in obese children [21].

Several studies have concluded with a positive correlation between BMI and serum TSH [22], which is in correspondence to the finding in our study that individuals with BMI ≥ 30 had higher TSH values than normal-weight individuals with BMI≤ 25. Our results were also augmented by a similar finding observed by Demir et al. in their study, in which they reported a positive correlation between TSH and BMI with an increased odds ratio of becoming obese with an increase in TSH and a decrease in FT3[23]. These changes may be either causally related or adaptive to the obesity state. Anupam Sharma et al. observed in their study that when TSH increases, the BMI will also increase in total and female euthyroid subjects [24]. Similar findings were found in the other two studies by Jin HY et al. and Lundback V et al [25,26].

Conclusion

We can conclude from our findings that there is no positive correlation between T3, T4 levels and body mass index (BMI). However, there is a positive relationship between TSH levels and an increase in BMI. These observations will aid in our understanding of the changes in thyroid function that occur as body fat increases.

Statement and Declarations

Author Contribution: Dr. Suhail Ahmad conceived the design of the study research and Dr. Shayees Arawa performed the research analysed the data and wrote the paper. Both the authors reviewed the manuscript.

Consent to Participate: Informed consent was obtained from all individual participants included in the study.

Consent to Publish: The authors affirm that human research participants provided informed consent for publication of their particulars and results when necessary.

Ethics Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the intuitional research committee of GMC, Srinagar, Jammu and Kashmir which follows the ethical standards as per ICMR Guidelines, New Drugs and Clinical Trials Rules, 2019 and ICH-GCP. The study was approved by the intuitional research committee of GMC, Srinagar [Ref. No: IRBGMC/PHYS 96]. The questionnaire and methodology for this study was approved by the intuitional research committee of GMC, Srinagar.

Data Availability Declaration: The data are available on request from the corresponding author. The data is not publicly available due to restriction that it contains information that could compromise the privacy of research participants.

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