# THE RELATIONSHIP BETWEEN SERUM THYROID-STIMULATING HORMONE AND VISCERAL FAT PROPORTION AND BODY MASS INDEX IN WOMEN OF REPRODUCTIVE AGE

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**Abstract::**The prevalence of overweight and obesity represents a global public health issue, often acting as an associated risk factor that can impact the function of various organs, including the thyroid gland. Considering the continuous rise in thyroid disease prevalence, it is particularly concerning that endocrine thyroid disorders are most common among women of reproductive age, between 20 and 45 years. Previous studies indicate a positive relationship between serum thyroid-stimulating hormone (TSH) and body mass index (BMI), implying that changes in body weight could be associated with thyroid dysfunction. Thyroid hormones play a crucial role in regulating energy expenditure through cellular respiration and thermogenesis and in determining basal metabolic rate. TSH, apart from regulating thyroid function, can influence thermogenesis, appetite, lipolysis, and lipogenesis, thereby indirectly affecting lipid metabolism and fat storage. The objectives of this study are to analyze the values of TSH, body weight, body height, body mass index (BMI), and visceral fat percentage in relation to the age of participants of reproductive age, as well as to examine the correlation between serum TSH levels, BMI, and visceral fat percentage in women of reproductive age. The research is an experimental, cross-sectional, observational, descriptive-analytical study that included a total of 88 female participants of reproductive age. The study was conducted in public and private laboratories in Bosnia and Herzegovina. Analysis revealed that 34.09% of participants were aged 18 to 30 years. Women aged 31 to 40 years accounted for 38.6%, and those aged 41 to 45 years comprised 27.27% of the participants. A physiologically normal amount of visceral fat was observed in 51.14% of the participants, while an increased amount of visceral fat was present in 48.86%. Based on visceral fat classification, 20% of participants under 30 years had an increased visceral fat level. Among those aged 30 to 40 years, the average proportion was 61.8%, while in the 41 to 45 age group, the average proportion of visceral fat was 66.7% (p=0.0005). Regarding BMI, the proportion of obese participants under 30 years was 3.3%; for those aged 31 to 40 years, it was 17.6%, and for participants aged 41 to 45 years, it was 16.7% (p=0.046). Analysis showed that 89.7% of participants aged 18 to 30 years had normal TSH values, 79.4% of those aged 31 to 40 years had TSH within reference values, and 87.5% of participants aged 41 to 45 years had reference TSH levels. No statistically significant difference was found (p=0.485). Analysis also established that TSH does not show a significant correlation with either BMI or visceral fat proportion. The study results demonstrated no significant correlation between serum TSH levels and BMI or visceral fat proportion in women of reproductive age. Despite other research suggesting a possible connection, this study did not confirm a significant impact of TSH on body mass parameters. The findings underscore the need for further research to more precisely understand the mechanisms associated with thyroid function and body weight.

**Keywords:** Thyroid-Stimulating Hormone, Visceral Fat Proportion, Body Mass Index, Women of Reproductive Age

## 1. INTRODUCTION

Excess body weight and obesity represent a serious global public health issue, as they are associated with an increased risk of developing metabolic, cardiovascular, and endocrine disorders. In addition to impairing quality of life, these factors can significantly affect the function of various organ systems, including the endocrine system (Rayman, 2018). In recent decades, increasing attention has been given to the relationship between thyroid function

and body weight parameters, with particular emphasis on thyroid-stimulating hormone (TSH) as a key regulator of thyroid function. According to data from the European Health Survey conducted in 2014, in the member states of the European Union (EU-28), a total of 51.6% of individuals aged 18 and older were classified as overweight or obese. Among them, 35.7% of the EU population was overweight, while 15.9% was obese (Eurostat, 2014). The prevalence of overweight and obesity varies between Bosnia and Herzegovina and Europe. In Bosnia and Herzegovina, a study conducted in 2012 on a population sample aged 25 to 64 years revealed that 37.5% of the population was classified as overweight (body mass index [BMI] between 25 and 29.9 kg/m²), while 21.2% were classified as obese (BMI ≥ 30 kg/m²) (Public Health Institute of the Federation of Bosnia and Herzegovina, 2012). Obesity in adults is a well-established risk factor for numerous chronic diseases, including type 2 diabetes, cardiovascular diseases, and certain types of cancer. The thyroid gland plays a central role in metabolic regulation through the production of triiodothyronine (T3) and thyroxine (T4), which influence energy expenditure, thermogenesis, lipid and carbohydrate metabolism, and fat distribution (Knežević, 2020). TSH, secreted by the pituitary gland, primarily stimulates the synthesis and secretion of these hormones. However, recent research suggests that TSH may also have a direct impact on lipid metabolism and fat storage. Adipose tissue is not merely a passive energy reservoir but an active endocrine organ that secretes various adipokines and pro-inflammatory mediators, which can influence the regulation of thyroid function (Liu et al., 2020). Studies indicate that elevated TSH levels are frequently observed in individuals with overweight and obesity. The increased fat mass may affect the hypothalamic-pituitary-thyroid axis through several mechanisms, including peripheral resistance to thyroid hormones, which can lead to a reduced tissue response to T3 and T4 in obese individuals, thereby causing compensatory TSH secretion; alterations in deiodinase expression, where increased type 2 deiodinase activity in adipose tissue of obese individuals may result in locally elevated T3 levels, subsequently affecting TSH secretion; and inflammatory processes and adipokines (such as leptin, resistin, and TNF-α), which are elevated in individuals with excess fat mass and may influence the regulation of the hypothalamus and pituitary gland, leading to increased TSH secretion (Marzullo et al., 2010). Visceral adipose tissue is metabolically more active than subcutaneous fat and plays a crucial role in the production of pro-inflammatory cytokines. An increased amount of visceral fat is associated with elevated levels of C-reactive protein (CRP), interleukin-6, and TNF-α, which may have a negative impact on thyroid function. Individuals with a higher proportion of visceral adipose tissue are more likely to develop subclinical hypothyroidism, characterized by a mild elevation in TSH levels while maintaining normal T3 and T4 values (Knežević, 2020). Given these findings, research focusing on women of reproductive age is particularly significant, as thyroid function alterations are frequently observed during this period and may be associated with changes in body weight and fat distribution. The objectives of this study are to analyze TSH levels, body weight, height, BMI, and visceral fat percentage in relation to the age of women of reproductive age and to assess the correlation between serum TSH levels, BMI, and visceral fat percentage in this population. The findings could contribute to a better understanding of the interaction between thyroid function and body weight metabolism, potentially leading to improved prevention strategies for obesity-related thyroid dysfunction.

## 2. PARTICIPANTS AND METHODS

his study is an experimental, cross-sectional, observational, descriptive-analytical study, including a total of 88 female participants of reproductive age (18 to 45 years). The research was conducted in public and private laboratories in Bosnia and Herzegovina, specifically at Agram Polyclinic Sarajevo, Atrium Laboratory Goražde, General Hospital Tešanj, and the Institute for Health Development of the University of Sarajevo – Faculty of Health Studies. The study took place between September and November 2023, following prior approval from private laboratories and faculty management. The sample was obtained using the snowball sampling method. Inclusion criteria for participation in the study were: female participants of reproductive age (18–45 years); participants without confirmed diagnoses of cardiovascular diseases, diabetes, or thyroid cancer; participants not using medications that could influence laboratory parameter values; participants who provided voluntary informed consent for participation. Exclusion criteria were: female participants younger than 18 or older than 45 years; male participants; women in menopause or postmenopause; participants with a confirmed diagnosis of cardiovascular diseases, diabetes, or thyroid cancer; participants undergoing therapy that affects laboratory parameter values. The laboratory analysis was conducted in compliance with all quality control standards. TSH concentration was determined using the electrochemiluminescence method on Cobas e 411 and Mindray-BS-480 analyzers. Body composition parameters were assessed using the Tanita SC 330ST body analyzer, including body weight, BMI, and visceral fat percentage. Body height was measured using an anthropometer. For statistical data processing, IBM SPSS Statistics 27.00 (IBM Corporation, Armonk, New York) was used.

## 3. RESULTS

Statistical analysis determined that the study included 30 participants (34.09%) aged 18 to 30 years. A total of 34 participants (38.6%) were aged 31 to 40 years, while 24 participants (27.27%) were between 41 and 45 years old. Table 1 presents the results of the statistical analysis of anthropometric parameters in relation to the age of the participants.

***Table 1. Analysis of Anthropometric Values in Relation to Participants' Age***

| Parameters | 18-30 years | | 31-40 years | | 41-45 years | | F | p |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | | |
| *Body height (cm)* | 168.64 | 6.28 | 169.18 | 5.44 | 167.75 | 4.62 | 0.468 | 0.628 |
| *Body weight (kg)* | 65.18 | 9.26 | 76.19 | 12.69 | 74.70[a] | 16.20 | **5.814** | **0.004** |
| *Visceral fat percentage* | 2.69 | 2.19 | 6.44 | 4.30 | 6.25 | 2.86 | **10.727** | **<0.001** |
| *Body mass index (BMI)* | 22.99 | 3.08 | 26.67 | 4.59 | 26.53 | 5.56 | **5.740** | **0.005** |

Source: Authors research

According to the results presented in Table 1, there was no significant difference in body height among participants across age groups, with mean values ranging from 167.75 cm to 169.18 cm in all age categories. The analysis of body weight showed that the mean body weight of participants aged 18 to 30 years was 65.18±9.26 kg, whereas the mean body weight in the 31 to 40-year-old group was 76.19±12.69 kg. Among participants aged 41 to 45 years, the mean body weight was 74.70±16.20 kg. A statistically significant difference was found, with participants under the age of 30 having significantly lower body weight ($F=5.814$, $p=0.004$). The mean visceral fat percentage in participants aged 18 to 30 years was 2.69±2.19, while in the 31 to 40-year-old group, it was 6.44±4.30. In participants aged 41 to 45 years, the mean visceral fat percentage was 6.25±2.86. A statistically significant difference was confirmed in visceral fat percentage across age groups ($F=10.727$, $p<0.001$), with the highest values observed in participants aged 31 to 40 years. The mean body mass index (BMI) for participants under 30 years was 22.99±3.08 kg/m², whereas in the 31 to 40-year-old group, the mean BMI was 26.67±4.59 kg/m². For participants aged 41 to 45 years, the mean BMI was 26.53±5.56 kg/m². A statistically significant difference in BMI values was observed among participants across different age groups ($F=5.740$, $p=0.005$).

***Table 2. Analysis of TSH Laboratory Values in Relation to Participants' Age***

| Variable | Reference Value | 18-30 years | 31-40 years | 41-45 years | $x^2$ | p |
|---|---|---|---|---|---|---|
| | | % | % | % | | |
| ***TSH*** | **No** | 10.3 | 20.6 | 12.5 | 1.448 | 0.485 |
| | **Yes** | 89.7 | 79.4 | 87.5 | | |

Source: Authors research

The analysis determined that 89.7% of participants aged 18 to 30 years had TSH values within the reference range. Among participants aged 31 to 40 years, 79.4% had TSH within the reference range, while in the 41 to 45-year-old group, 87.5% of participants had TSH values within the reference range. No statistically significant difference was observed in relation to participants' age ($p=0.485$).

***Table 3. Correlation Between TSH Levels and Anthropometric Parameters***

| Parameter | | Body height (cm) | Body weight (kg) | Visceral fat percentage | Body mass index (BMI) |
|---|---|---|---|---|---|
| TSH | r | 0.174 | 0.048 | -0.052 | -0.011 |
| | p | 0.112 | 0.669 | 0.614 | 0.721 |

Source: Authors research

The correlation analysis of thyroid-stimulating hormone (TSH) levels with body height, body weight, visceral fat percentage, and body mass index (BMI) revealed that TSH does not show a significant association with any of the analyzed anthropometric variables.

**4. DISCUSSIONS**

The analysis of the results of this study provides a deeper understanding of the relationship between TSH concentration and various anthropometric parameters in women of reproductive age. In this discussion, our findings are compared with relevant previous studies that have examined similar associations. The focus is placed on analyzing similarities and differences in findings while considering possible factors that could explain the observed variations among studies. Our results indicate that body weight values significantly increase with age, with the lowest value recorded in the 18–30 age group (65.18±9.26 kg), while older participants had significantly higher body weight. These findings are consistent with the cross-sectional study by Knudsen et al., which demonstrated that body weight and BMI progressively increase with age due to a decline in basal metabolism and hormonal changes that favor fat accumulation (Knudsen et al., 2005). Furthermore, BMI values in our study were significantly higher in older participants, with those over 30 years of age having average BMI values above 26 kg/m², indicating a tendency toward overweight. Similar findings were reported by Fox et al., who analyzed longitudinal changes in BMI and found that waist circumference also increases with age, suggesting an accumulation of abdominal fat (Fox et al., 2008). The highest proportion of visceral fat in our study was recorded in the 31–40 age group (6.44±4.30), while younger participants had significantly lower values. These results align with the German study by Witte et al., which showed that visceral fat increases significantly after the age of 30, primarily due to declining estrogen levels and increased insulin sensitivity, contributing to changes in fat distribution (Witte et al., 2017). Additionally, we observed that older participants had higher BMI values and a greater proportion of visceral fat, which is consistent with the study by Rotondi et al., who analyzed the association between metabolic factors and visceral fat in women. Their findings suggest that women with higher BMI values have a greater tendency to accumulate visceral fat, which increases the risk of metabolic disorders (Rotondi et al., 2009). The obtained results can be explained by physiological and metabolic changes that occur with aging, including the loss of muscle mass, hormonal alterations, and a slowdown in basal metabolism. Furthermore, lifestyle factors, dietary habits, and physical activity levels can significantly influence fat accumulation and changes in body composition. A cross-sectional Chinese study by Fu et al. demonstrated a significant positive correlation between TSH and BMI, where an increase in BMI values was accompanied by an increase in TSH concentration. Participants with higher BMI values also had higher TSH levels. These findings do not align with our results, as we did not find a significant association between TSH and BMI (Fu et al., 2021). In the study by Wang et al., Mendelian randomization was used to investigate causal relationships between TSH and obesity. Their results suggest that a genetically elevated BMI can lead to an increase in TSH levels, but elevated TSH levels do not cause changes in BMI or obesity (Wang et al., 2019). A cohort study by Manji et al. analyzed euthyroid participants and found no significant association between serum TSH levels and BMI. These findings are in line with ours, suggesting that within the reference range, TSH has no significant impact on body weight (Manji et al., 2006). De Pergola et al. investigated the relationship between TSH and fat distribution in 201 obese women and found a positive correlation between TSH levels and waist circumference, as well as visceral fat percentage, indicating an association with visceral fat accumulation. These findings differ from ours, as we did not find a significant correlation between TSH levels and visceral fat percentage (De Pergola et al., 2007). The discrepancies between our results and previous studies can be attributed to differences in methodology, sample size, participant age range, and inclusion and exclusion criteria. For example, our study focused specifically on women of reproductive age, while other studies included a broader population. Additionally, variations in dietary habits, physical activity levels, health status, and genetic factors among populations may have influenced the results. In line with our findings and those of other studies, it is evident that further research is needed, incorporating a larger sample of participants and analyzing additional factors such as hormone levels, lipid metabolism, and insulin sensitivity to gain a more precise understanding of the underlying mechanisms driving these changes.

## 5. CONCLUSIONS

The results of this study demonstrated a significant increase in body weight, BMI, and visceral fat percentage with age, which aligns with the physiological changes that occur during maturation in reproductive age. A decline in basal metabolism, changes in hormonal status, and the redistribution of adipose tissue may contribute to increased body weight in older age groups. However, these changes were not associated with variations in TSH concentration. Furthermore, we established that there is no significant correlation between thyroid-stimulating hormone (TSH) levels and the analyzed anthropometric parameters, including body height, body weight, BMI, and visceral fat percentage in women of reproductive age. Although previous studies have suggested a potential relationship between TSH levels and BMI, as well as visceral fat accumulation, our findings did not confirm this correlation. Given the conflicting results in the existing literature, this study highlights the need for further research focusing on larger sample sizes to more precisely clarify the nature of the relationship between thyroid function and body weight metabolism. A deeper understanding of these associations could have significant implications for the prevention of metabolic disorders related to thyroid dysfunction and serve as a foundation for the development of targeted preventive and interventional programs.

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