

THE CORRELATION BETWEEN BODY MASS INDEX AND THYROID STIMULATING HORMONE IN EUTHYROID PERSONS

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The aim of the study was to determine the correlation between body mass index (BMI), thyroid stimulating hormone (TSH), and thyroid hormones in euthyroid persons. The study included 396 euthyroid participants. The subjects with already established disease of the thyroid function were excluded. In all subjects we measured weight, height and determined BMI. According to BMI values, the subjects were divided into three groups: group A - BMI up to 24.9 (normal weight); group B - BMI from 25 to 29.9 (overweight); group C - BMI over 30 (obesity). In all subjects we determined serum TSH and free thyroxine (FT4) levels and antibodies to thyroid peroxidase (TPOAb). According to TSH levels, the subjects were divided into two groups: TSH up to 2.5, and TSH higher than 2.5. There is an increase in TSH levels with increasing of BMI. In group C, TSH values were significantly higher than in the groups A and B, and were also higher than the mean values of TSH in all subjects. TSH level in group B were slightly higher compared to the group A but there is no statistically significant difference. TPOAb values increase with increasing of BMI. The mean value of BMI was significantly lower in the group of patients with TSH values lower than 2.5, compared to the mean value of BMI in the group of patients with TSH values higher than 2.5. The relationship of BMI and TSH points to significant positive correlations of two parameters, except in group A. We found a significant degree of positive correlation between BMI and TSH, which remains within the normal range. There are also significant changes in the of TPOAb values. There is no significant changes in the FT4 levels.

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Key words: euthyroid persons, BMI, TSH

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Introduction

Nowadays, weight gain is a global epidemiological problem and is associated with numerous cardiovascular and metabolic diseases. Increasing body mass index (BMI) has probably resulted in the shortening of life expectancy. The etiology of obesity is multifactorial, and among other things, some endocrine diseases may be the cause of weight gain. Hypothalamic-pituitary-thyroid axis controls and influences the energy and oxygen consumption, metabolic rate, thermogenesis and weight. Hyperthyroidism is usually accompanied by the loss of body weight, while in hypothyroidism body weight increases. Subclinical hypothyroidism in recent years is

gaining in importance due to its frequency and potential impact on the incidence of cardiovascular and metabolic diseases. Even small differences in thyroid function under normal hormone levels can have a significant impact on the regulation of body weight. All this points to the great importance of the relationship between thyroid function and weight.

The relationship of body weight to TSH is increasingly gaining in importance, but the obtained data vary, from the fact that there is a positive correlation between BMI and TSH, to the one that there is no correlation at all. Increased body weight and obesity will rather lead to changed thyroid function than vice versa. The aim of the study was to determine the correlation between BMI, TSH and thyroid hormones in euthyroid persons.

Methods

The study included 396 euthyroid persons, 236 women and 160 men, aged 27 to 64 years. We excluded the subjects with already established disease of the thyroid function. In all subjects, weight, height and BMI were determined. Body weight and height were measured on the same digital weight machine. BMI is defined as body weight in kg divided by the square of body height in meters. According to BMI

values, the subject were divided into three groups: group A – BMI up to 24.9 (normal weight); group B - BMI from 25 to 29.9 (overweight); group C - BMI over 30 (obese). All the subjects had serum TSH and free thyroxine (FT4) levels determined as well as antibodies to thyroid peroxidase (TPOAb). According TSH levels, all subjects were divided into two groups: TSH levels up to 2.5 and TSH levels higher than 2.5.

All hormones levels were assessed at the Institute of Biochemistry, Clinical Center Niš on Beckman UNICELL DXI 600, using a chemiluminiscent method. The reference ranges for TSH are 0.40-4.60mU/l, for FT4 7-16pmol/l, and TPOAb < 14. The results were expressed as mean \pm standard errors mean (S:E:M:). Significance of differences between the groups was determined using the Least Significant Difference (LSD) test. Statistically significant differences were assumed at $p \leq 0.05$. Pearson's coefficient was used to determine a correlation between TSH, FT4 and BMI in all groups.

Results

Table 1. TSH, FT4 and TPOab values in all groups

	Group A	Group B	Group C	All
TSH (mU/l)	1.89 \pm 0.67	2.06 \pm 1.25	2.47 \pm 1.78	2.12 \pm 2.06 *
FT4 (pmol/l)	11.58 \pm 2.64	11.04 \pm 2.06	10.32 \pm 2.89	11.14 \pm 2.72
TPOab	4.6 \pm 2.5	5.7 \pm 3.0	25.8 \pm 6.5	10.3 \pm 5.3 *

* $p < 0.05$

Table 2. BMI and FT4 values according to TSH

	TSH < 2.5mU/l	TSH > 2.5mU/l
BMI	26.3 \pm 3.1	29.7 \pm 4.6 *
FT4 (pmol/l)	11.44 \pm 2.58	10.22 \pm 2.71

* $p < 0.01$

Table 3. Correlation between BMI and TSH in all groups

Group	All	A	B	C	TSH < 2.5	TSH > 2.5
ρ	0.151	0.016	0.101	0.273	0.113	0.237
p	0.021	0.31	0.043	0.007	0.042	0.0009

Discussion

The link between thyroid hormone levels and body weight is well known, with weight gain in hypothyroidism and decrease in body weight in hyperthyroidism. Changes of TSH levels were observed with increasing of BMI in euthyroid persons. In our study, we determined the connection between TSH values and the values of BMI in euthyroid persons. It was observed that with increasing of BMI, TSH levels also increase, but remain within normal limits. In all the groups, there is an increase of medium TSH, which reached statistical significance. An increase of TSH levels is significant in groups with higher BMI values, indicating significant degree of correlation between TSH and BMI in overweight group and in the

group with obesity. Similar changes were observed in the TPOab values, while there was no significant difference in FT4 levels. Some authors have found decreasing values of FT4 and a negative correlation between BMI and FT4 (1). There is no change in the triiodothyronine, T3, levels and its value is not correlated with the values of BMI, although increasing of BMI shows an increase in T3/T4 relationship (2). Most authors presented similar results with an increase in TSH levels with increasing of BMI, with no significant change in the FT4 value. There are few works that show no difference in TSH with increasing of BMI (3).

Our results show no difference between men and women, while some authors obtained significant increase in TSH level in a group of obese women. Mean values of the levels of TSH, FT4 and TPOAb per group are shown in Table 1. An increase in TSH levels with increasing BMI was noticed. In group C, TSH values were significantly higher than those in groups A and B as well as mean TSH values in all the subjects. TSH values in group B were slightly higher compared to the group A, but there was no statistically significant difference. TPOAb values increase with increasing of BMI. The values in group C were significantly higher than the values in the groups A and B and mean values obtained for all subjects. The mean value of BMI was significantly lower in the group of patients with TSH levels lower than 2.5 compared to the mean value of BMI in the group of patients with TSH higher than 2.5. (Table 2).

The relationship between BMI and TSH shows positive correlations between the two parameters in all groups. Correlation was not significant only in group A (Table 3).

(4). It is not clear whether weight changes affect thyroid function and in what way. It is possible that the increase in adipose tissue and insulin resistance affect the thyroid function (5). According to some authors, visceral adipose tissue plays a far more significant role in changing the TSH levels than the subcutaneous adipose tissue (6). This is indicated by a positive correlation between TSH values and waist and hip circumference and waist / hip ratio (7). On the other hand, there is a possibility that even small changes in the thyroid function within the normal range may play a role in the change of body weight. It is possible that there is an ability of the adipose tissue to change the expression of TSH receptors (8), so that there is a certain degree of hormone resistance, similar to the insulin resistance.

Some authors describe the connection between leptin and TSH so that leptin may be one of the mediators that cause an increase of TSH in obesity (9). However, most authors have not found a significant correlation between leptin and TSH in obese patients, although both hormones show a positive correlation with the increase in body weight (10). TSH production is also influenced by transmitters that influence body weight and satiety, and they primarily include neuropeptide Y and α -melanocyte-stimulating hormone. The presence of TSH receptors on adipocytes suggests that a positive correlation of TSH and BMI can have an important physiological role and also point to a possible existence of the hypothalamic-pituitary-adipocyte axis, with numerous metabolic consequences. As thyroid hormones and TSH have a significant role in the pro-

cesses of lipolysis and thermogenesis, the changes in their values can be part of adaptation process in obesity. On the other hand, an increase in TSH level can stimulate the release of adipocytokines from adipose tissue and contribute to the proinflammatory state and an increase in insulin resistance in obesity (11). Synthesis of TSH and thyroid hormones can be affected by the magnification of caloric intake and fat mass.

Sari et al. have shown in women that reduction in body weight of 10% leads to decreased TSH levels (12). There is also an impact of smoking on the connection between TSH and BMI. Some authors find a significant positive correlation between BMI and TSH only for non-smokers, while in smokers it loses significance (11). The impact of smoking on thyroid function is well-known, also affecting changes in body weight. The lack of results may lie in the fact that lean body mass has not been determined but BMI only. Lean body mass is probably the major determinant for l-thyroxine level, and if increased, it may require an increased TSH stimulation of the thyroid gland to maintain the normal thyroid hormone levels (13).

Conclusion

In our study we found a significant degree of positive correlation between BMI and TSH, which remains within the normal range. There are also significant changes in the value of TPOAb levels. No significant changes in FT4 levels were found.

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KORELACIJA INDEKSA MASE TELA I STIMULIRAJUĆEG HORMONA ŠTITNE ŽLEZDE KOD EUTIREOIDNIH OSOBA

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Cilj rada bio je utvrditi korelaciju između indeksa telesne mase (body mass index, BMI), stimulirajućeg hormona štitne žlezde (TSH) i tireoidnih hormona kod eutireoidnih osoba. U ispitivanje je uključeno 396 eutireoidnih osoba. Nisu uključene osobe sa poznatim oboljenjem tiroidne funkcije. Kod svih ispitanika izmerena je telesna težina i visina i određen BMI. Prema vrednostima BMI podeljeni su u tri grupe; do 24,9 normalno uhranjeni, grupa A; od 25-29,9 sa prekomernom težinom, grupa B i preko 30 gojaznih, grupa C. Kod svih ispitanika su određivane vrednosti serumskog TSH, slobodnog tiroksina (FT4) i antitela na tiroidnu peroksidazu (TPOab). Prema vrednostima TSH ispitanici su podeljeni u dve grupe, TSH do 2,5 i preko 2,5. Zapaža se porast vrednosti TSH sa porastom BMI. Vrednosti TSH su statistički značajno veće u grupi C u odnosu na grupu A i B, kao i u odnosu na srednje vrednosti TSH svih ispitanika. Vrednosti TSH u grupi B su nešto veće o odnosu na grupu A, ali nema statistički značajne razlike. Vrednosti TPOab rastu sa porastom BMI. Srednja vrednost BMI je značajno niža u grupi ispitanika sa vrednostima TSH manjim od 2,5 u odnosu na srednju vrednost BMI u grupi ispitanika sa vrednostima TSH većim od 2,5. Odnos BMI i TSH pokazuje pozitivnost korelacije dva parametra, osim u grupi A. Utvrdili smo značajan stepen pozitivne korelacije BMI i TSH, koji ostaje u okviru granica normalnih vrednosti. Postoje i značajne promene vrednosti TPOab. Nema značajnih promena vrednosti FT4.

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Ključne reči: eutireoidne osobe, BMI, TSH