# CORRELATIONS BETWEEN BODY MASS INDEX AND LEVEL OF THYROID-STIMULATING HORMONE (TSH) IN STROKE PATIENTS

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***Abstract:*** *Subclinical hypothyroidism (HoTS) is defined by the high thyroid-stimulating hormone (TSH) and normal free thyroxine (FT4) and it is associated with weight gain and atherogenic lipid profile. Current studies have shown that in obese patients, there is a positive association between elevated TSH levels and body mass index (BMI). The aim of this study was to investigate to what extent HoTS related obesity was a risk factor for stroke and to investigate the correlations between TSH level and BMI in patients with stroke and HoTS versus patients with stroke and without HoTS. The study was conducted on 154 patients who had suffered a stroke and a control group consisting of 15 patients with normal thyroid function (NT) without signs and symptoms of stroke. The results revealed a higher incidence of obesity in patients with HoTS and stroke compared with patients with stroke and without HoTS.*

## INTRODUCTION

In the last decade, there has been an increased interest in subclinical hypothyroidism (HoTS) because it was found that its effects are the same with those of hypothyroidism clinically manifested. HoTS is defined by the elevated thyroid-stimulating hormone (TSH) (up to 10.00 μU/ml) and normal free thyroxine (FT4). In HoTS, moderate weight gain is often found, due to growing deposits of mucopolysaccharides and retention of salt and water.(1) In obesity, serum concentrations of FT4, FT3 and TSH are normal if the patient has an neutral energy balance, but it has been found that small increases in TSH are associated with a higher incidence of obesity.(2) In obese patients, there is a positive association between elevated levels of TSH and BMI.(3)

It has been demonstrated that obesity favours atherogenesis, dyslipidemia in obese patients being five times more frequently than in the general population. Thyroid hormones influence the metabolic processes, thyroid deficiency leading to excess weight and an atherogenic lipid profiles.(4)

In general, stroke risk assessment guidelines have been focused on just a few risk factors: blood pressure, blood lipids, obesity, sedentary lifestyle, smoking. To develop effective therapeutic and prophylactic strategies, it is important to take into account a large number of risk factors.

## PURPOSE

The aim of this study was to investigate to what extent HoTS related obesity was a risk factor for stroke and to investigate correlations between TSH level and BMI in patients with stroke and HoTS versus patients with stroke and without HoTS.

## MATERIALS AND METHODS

The study was conducted on 154 patients who had suffered a stroke and were hospitalized in Asklepios Neurological Hospital from Schildautal in Germany between 2013 and 2015 and a control group consisting of 15 patients with normal thyroid function (NT) without signs and symptoms of stroke, hospitalized in the Endocrinology Clinic of Sibiu, between 2014 and 2015. The age of the patients included in the study ranged between 60 and 80 years old.

Within the study, there were made up two groups of patients: one group of patients with stroke and HoTS (undiagnosed with HoTS previously to stroke), and a control group including patients with stroke and without HoTS. There were no significant differences regarding age between the treatment group and the control one.

After applying the inclusion and exclusion criteria, of the 154 stroke patients, there were included in the study a total of 116 patients of whom 72 were men and 44 were women.

For statistical analysis, there were randomly selected out of the patients with stroke and without HoTS, a number of 15 patients.

Exclusion criteria were: patients receiving amiodarone treatment, previous diagnosis of hypothyroidism or hyperthyroidism, severe obesity, chronic heart failure, severe systemic diseases, chronic renal and hepatic diseases, malignant tumours, patients with no thyroid hormone dosages.

NT means normal values for TSH and FT4. HiTS was defined by TSH concentration below 0.270 μU/ml with normal FT4. In HoTS, TSH value is above the normal limit, between 5.00 and 10.00 μU/ ml and FT4 is normal.

BMI is the ratio between weight (kg) and height ($m^2$) squared and was calculated by measuring the height and determining the body weight, by weighing with a standardized scale.

Based on the Word Health Organization (WHO) criteria and the International Obesity Task Force (IOTF), people with BMI between 18.5 and 24.9 $kg/m^2$ are considered normal weight. Overweight is defined as a BMI between 25 and 29.9 $kg/m^2$. Obesity class I implies a BMI between 30 and 34.9 $kg/m^2$, obesity class II - BMI between 35 and 39.9 $kg/m^2$ and obesity class III - BMI greater than or equal to 40 $kg/m^2$.

AVC diagnosis was made based on clinical and laboratory signs. We performed the following laboratory examinations: magnetic resonance imaging (MRI) brain computed tomography (CT) cranial angioRMN or angioCT for intracranial vascular exploration, ultrasound Doppler exploration for extracranial vascular examination, electrocardiogram, electroencephalogram, chest X-ray, lumbar

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puncture, oximetry.

In our laboratory, normal values for TSH ranged between 0.35 to 4.94 µU/ml, for FT3 between 1.71 to 3.71 pg/m and for FT4, between 0.7 - 1.48 ng/dl.

For statistical analysis, we used Student T-test.

## RESULTS

The total number of stroke patients included in the study was 116.

Results showed 8 patients with HoTS, 13 patients with HiT and 95 patients with NT.

The control group included 15 patients with NT and without stroke, 9 women and 6 men with a mean age of 69.53 ± 4.10 years. Average values were calculated for BMI = 25.72 ± 2.20, TSH = 1.77 ± 0.76 and FT4 = 1.17 ± 0.26.

There were 5 female patients and three males with HoTS and stroke with a mean age of 75 ± 3.29 years, mean BMI = 27.94 ± 3.61, TSH = 7.27 ± 2.11 and FT4 = = 1.06 ± 0.19.

7 women and 8 men with an average age of 73.87 ± 5.59 had NT and stroke. The average values for the parameters analyzed were: BMI = 27.12 ± 4.20, TSH = 1.44 ± 0.22 and FT4 = = 1.32 ± 0.24.

**Table no. 1. The mean values and standard deviations of TSH and BMI in patients with stroke and HoTS compared with patients with stroke and NT**

| Parameters | Patients with stroke and HoTS (N=8) | Patients with stroke and NT (N=15) | *p* |
|---|---|---|---|
| TSH (µU/ml) | 7.27±2.11 | 1.44±0.22 | p=NS |
| BMI (kg/m$^2$) | 27.94±3.61 | 27.12±4.20 | p=NS |

**Table no. 2. The mean values and standard deviations of TSH and BMI in patients with stroke and HoTS compared with patients without stroke and NT (control group)**

| Parameters | Patients with stroke and HoTS (N=8) | Patients with NT without stroke (N=15) | *p* |
|---|---|---|---|
| TSH (µU/ml) | 7.27±2.11 | 1,44±0,22 | p=NS |
| BMI (kg/m$^2$) | 27.94±3.61 | 25.72±2,20 | p=NS |

**Table no. 3. The mean values and standard deviations of TSH and BMI in patients with stroke and NT compared with patients without stroke and NT (control group)**

| Parameters | Patients withy NT and stroke (N=15) | Patients with NT without stroke (N=15) | *p* |
|---|---|---|---|
| TSH (µU/ml) | 1.44±0.22 | 1.77±0.76 | p=NS |
| BMI (kg/m$^2$) | 27.12±4.20 | 25.72±2.20 | p=NS |

**Figure no. 1. BMI frequency histogram in the 3 groups studied**

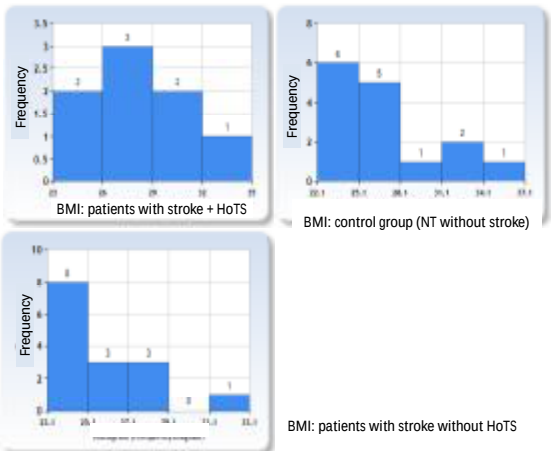


**Table no. 4. The incidence of overweight and obesity in the three study groups**

| Patients | Stroke +HoTS | Stroke without HoTS | NT without stroke |
|---|---|---|---|
| Normal weight | 2 (25%) | 8 (53,3%) | 6 (40%) |
| Overweight | 3 (37,5%) | 6 (40%) | 6 40%) |
| Obesity class I | 5 (62,5%) | 1 (9,3%) | 3 (20%) |

## DISCUSSIONS

Thyroid dysfunction is accompanied by changes in body weight.(5,6)

The association between HoTS and obesity is well established. Our study confirms this: 62.5% of patients with stroke and HoTS had the BMI over 30 (obesity class I), versus 9.3% of patients with stroke without HoTS. Only 25% of the patients with stroke and HoTS had normal weight, compared to 53.3% of patients with and without HoTS. Overweight and obesity had about the same incidence in the patients with stroke and without HoTS and in the NT patients without stroke. However, comparing the mean value of BMI in the three study groups, there were no significant statistical differences.

Thyroid hormones regulate both energy consumption and basal metabolism. In addition, the reduced basal metabolism is a risk factor for obesity. The question is whether changes in TSH and thyroid hormones in obesity are the cause or the result in weight gain.(7)

Recent studies have found that adipocytes and preadipoctytes express TSH receptors by acting on them inducing adipogenesis.(2) In contrast, other studies have shown no link between BMI and thyroid function in people with euthyroidism or in patients with HoTS.(8,9)

Abnormalities of thyroid function and TSH are largely normalized after weight loss.(10) Therefore, elevated TSH in obese patients seems to be a consequence rather than a cause of obesity. There are several hypotheses for elevated TSH in obesity, such as increase of leptin or of factors of chronic inflammation.(10) There has been proven the association between obesity and increased CRP, as well as the additional effect as a risk marker for stroke.(11)

Positive association between TSH and BMI or waist circumference has also been described.(12,13) At the same time, obesity is a risk factor for stroke.(14) It has been found that HoTS stimulates cytokines with pro-inflammatory role.(15) Cytokines favour the development of metabolic syndrome components, thus increasing the risk of atherosclerosis.(16)

Our research allows us to conclude that excess weight and obesity are risk factors in patients with HoTS. Consequently, all patients at risk of stroke should be screened for thyroid insufficiency, and thyroid investigation should be considered part of stroke risk stratification.

We consider that our study has certain limitations regarding the reduced number of subjects in the study. Even in these circumstances, it can be said that HoTS is associated with weight excess and/or obesity, which are increased risk factors for stroke.

## CONCLUSIONS

- Our research found a higher incidence of obesity in patients with HoTS and stroke compared with patients with stroke and without HoTS.
- Overweight and obesity are risk factors for stroke in patients with HoTS. Consequently, for all patients at stroke risk, thyroid function exploration should be considered as integral part of stroke risk stratification.

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