Thyroid Stimulating Hormone Concentrations Within the Normal Reference Range Are Not Associated with Differences in Energy Expenditure, Macronutrient Oxidation or Body Composition

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Introduction

Patients with overt thyroid disease have altered metabolic function. It is not clear whether metabolic function varies with normal thyroid function.

Study Aim: To determine the relationships between serum thyroid stimulating hormone (TSH) concentrations within the normal range and markers of energy expenditure, macronutrient oxidation, and body composition in healthy control and euthyroid Levothyroxine treated women.

Hypotheses:

1. Energy expenditure and fat oxidation rates will be higher in the low-normal TSH concentration group.
2. Body fat percentage and protein and carbohydrate oxidation rates will be higher in the high-normal TSH concentration group.

Methods

Participants: Sixty-five, euthyroid women 20-74 years of age with no thyroid disease (controls; n=16) or who received Levothyroxine treatment for hypothyroidism (n=49) were included.

Group Assignment: Participants were divided into low-normal (0.42-2.49 mU/L, n = 46) and high-normal (2.50-4.89 mU/L, n = 19) TSH concentration groups.

Study Variables:

Thyroid stimulating hormone (TSH) concentrations were measure by ICMA, functional sensitivity of 0.01 mU/L

Total Energy Expenditure (TEE) was measured by Doubly Labeled Water (DLW)

Resting Energy Expenditure (REE), Thermic Effect of Food (TEF) and Respiratory Quotient (RQ) were measured by indirect calorimetry (IC):

- VO_2 = volume of O_2 consumed; VCO_2= volume of CO_2 produced
- REE (kcal/d) = [3.941 (VO_2, L/min) + 1.106 (VCO_2, L/min)] + [2.17 (UUN, g/d) x 1440 min/day]
- TEF (kcal/meal) measured for 15 min every half hour for 6 hours after consuming standard liquid meal (Ensure Plus)
- RQ = VCO_2/VO_2

Macronutrient Oxidation Rates calculated as:

- Carbohydrate (g/d) = 4.59 (VCO_2, L/min) - 3.25 (VO_2, L/min - 3.68 (UUN, g/min)* 1440 min/d
- Fat (g/d) = 1.69 (VO_2, L/min) - 1.69 (VCO_2, L/min) - 1.72 (UUN, g/min) * 1440 min/d
- Protein (g/d) = 6.25 g Protein / g Nitrogen (UUN, g/min)*1440 min/d

Methods…

Body Composition: total, lean and fat mass measured by whole body Dual Energy X-ray Absorptiometry (DEXA)

Statistical Analyses: Independent t-tests and linear regression models were used to determine significant differences between groups and relationships with TSH concentrations. $P \leq 0.05$ were considered significant .

Results

Table 1. Subject Characteristics*

	Low-Normal TSH (n= 46)	High-Normal TSH (n=19)
TSH (mU/L)	1.42 0.65	3.54 0.76
Age (yr)	45.0 11.5	44.2 11.4
Weight (kg)	72.7 15.3	82.2 22.3†
Height (cm)	164 6.9	164 4.3
BMI (kg/m²)	27.1 5.4	30.5 8.0†

*Mean SD
† p-value ≤ 0.05 compared to low-normal TSH group using unpaired t-tests

Table 2. Components of Energy Expenditure*

	Low-Normal (n=46)	High-Normal (n=19)
TEE (kcal/d)	2275 413	2483 485
REE (kcal/d)	1269 162	1340 223
REE/TEE (%)	56.7 ± 6.9	55.0 ± 8.9
TEF (kcal/meal)	40.3 15.1	43.1 16.0
RQ	0.84 0.05	0.83 0.05

*Mean SD; Total Energy Expenditure (TEE), Resting Energy Expenditure (REE), Thermic Effect of Food (TEF), Respiratory Quotient) (RQ)

Table 3. Fasting Macronutrient Oxidation Rates*

	Low-Normal (n=46)	High-Normal (n=19)
Carbohydrate (g/d)	128 ± 61.3	123 ± 49.6
Fat (g/d)	55.8 ± 24.6	64.9 ± 31.9
Protein (g/d)	53.0 ± 24.1	52.2 ± 18.1
Total Macronutrient Oxidation (kcals/d)	1226 ± 157	1286 ± 210
Total Macronutrient Oxidation/REE (%)	96.6 ± 3.6	96.1 ± 1.9
Total Macronutrient Oxidation/TEE (%)	35.0 ± 10.3	31.8 ± 9.3

*Mean SD

Table 4. Components of Body Composition*

	Low-Normal (n=46)	High-Normal (n=19)
Total Mass (kg)	72.6 15.4	80.3 23.3
Lean Mass (kg)	45.0 6.1	47.7 7.4
Fat Mass (kg)	24.9 9.9	32.4 15.6
Percent Body Fat (%)	33.8 7.6	37.6 8.7

*Mean SD

Figure 1. Relationship Between Serum TSH and Weight

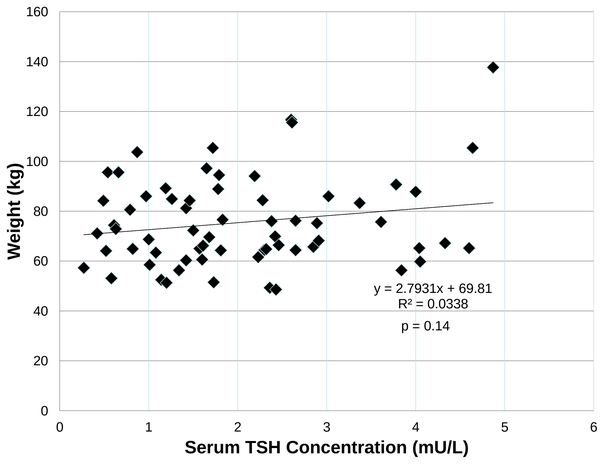
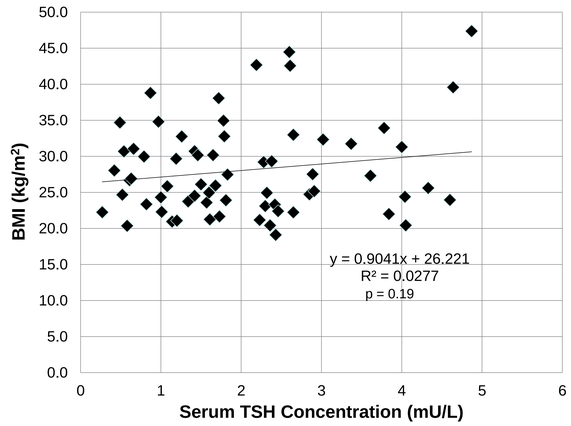


Figure 2. Relationship Between Serum TSH Concentration and BMI



Summary & Conclusions

To the best of our knowledge, this is the first study to combine measurements of TEE by DLW with REE and TEF by IC to assess differences in energy expenditure and macronutrient oxidation among women with TSH concentrations within the low- and high-normal range.

Average body weight and BMI were significantly lower in the low-normal than the high-normal TSH concentration group (p=0.05), however regression across the TSH normal range demonstrated only a relatively small effect.

No other significant relationships between metabolic markers and serum TSH concentrations were detected.

These results differ from those reported in previous epidemiologic studies that showed no, or only a modest, relationship between TSH concentration and body weight. In addition, longitudinal studies suggest that weight gain causes TSH concentration to increase, raising questions about the causative nature of this relationship.

We conclude that energy expenditure, macronutrient oxidation, and body composition are not associated with variations in TSH concentrations within the established normal range.

This conclusion should be interpreted with caution given the cross-sectional study design used and the relatively small sample size of the high-normal TSH concentration group.

Our next step is to explore the relationships between TSH concentrations in the normal range and metabolic function within this same sample using longitudinal analyses.

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