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Effect of diet plan on thyroid function in hypothyroid obese patients

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Abstract
Background: Obesity and hypothyroidism are both common disorders within the general population; Studies of thyroid function after diet-induced weight loss in patients with obesity have yielded conflicting results. The aim of the study was to prospectively evaluate the effect of diet plan on weight, body composition and thyroid function in patients with hypothyroid and obesity.
Patient and method: Serum levels of thyroid-stimulating hormone (TSH), total thyroxine (T4), and total triiodothyronine (T3) in hypothyroid patients with obesity were analyzed before and at the end of a 3-month weight loss program. Relationships between body weight or composition and changes in thyroid function were also investigated. Each study participant acted as his/her own control.
Results: The study population consisted of 42 hypothyroid patients with obesity (5 men and 37 women; mean ± SD age: 32.5 ± 11). The mean BMI was 38.2 ± 5.2 kg/m^2 before the program and 33.8 ± 5.1 ($p < 0.0001$) at the end, with a mean body weight loss of 11 kg ($p < 0.0001$) and a mean fat mass loss of 8.7 kg ($p < 0.0001$). The weight and fat mass losses were not significantly correlated with the serum concentrations of TSH, T3.However weight reduction percent significantly correlated with T4 measured at the end of the program.
Conclusion: A 3-month weight loss program produced weight and fat mass losses with inducing significant changes in TSH, T3 without significant change in T4 in patients with obesity and hypothyroid.

Keywords: Thyroid function, hypothyroid, obesity, diet, weight loss

Introduction

Obesity is the result of a sustained imbalance between energy intake and energy expenditure (EE) [1]. This condition has reached epidemic proportions, and its health and economic consequences are enormous [2, 3]. The rapidly growing prevalence of obesity has become a global public health concern because excessive weight gain predicts the incidence of several major chronic diseases, including diabetes, cardiovascular disease, and certain types of cancer [3, 4]. The common first-line treatment modality is behavior modification, which includes dietary restriction and increased physical activity, aimed at generating a sustained negative energy balance [5, 6].

There is growing scientific and clinical interest in the interactions between obesity and thyroid function [7]. Thyroid hormones are known to be involved in the metabolic pathway in the regulation of basal metabolism and energy expenditure; and also have a role in lipid and glucose metabolism [8]. Thyroid dysfunction has been reported in patients with obesity [9]. In most studies, a high body mass index (BMI) was found to be associated with elevated serum levels of thyroid stimulating hormone (TSH) and low serum levels of thyroxine (T4) [10, 11].

Obesity and hypothyroidism are both common disorders within the general population; a recent study showed that the prevalence of hypothyroidism in a cohort of morbidly obese subjects' candidate to bariatric surgery was approximately 18% [12]. The impact of weight change on thyroid function has been explored in several observational studies, although the results were inconsistent [11, 13, 14]. For example, a caloric restriction diet has been linked to a low serum T3 concentration in lean and weight-stable healthy humans [15]. In patients with obesity, weight loss was associated with a decrease in TSH and T3 levels (relative to baseline levels), regardless of the weight loss strategy used (caloric restriction or bariatric surgery) [16, 17, 18]. A few observational prospective studies yielded mixed findings regarding the association of thyroid hormones or function with changes in body weight or body mass index (BMI) [19, 20].

Aim of the study

This prospective study aimed to evaluate the effect of diet plan on weight, body composition and thyroid function in patients with hypothyroid and obesity.

Patient and method

This was a prospective study carried out in the Department of Nutrition at medical city Hospital (Baghdad, Iraq), during period between first of May 2024 to first of September 2024. The inclusion criteria included Patients with obesity (BMI >30 kg/m^2), and hypothyroid on stable dose of thyroxine. Prior and after 3-months of weight loss program, each subject was submitted to anthropometric measures, body composition analysis by In Body 270 device and blood sampling for hormonal assays. Blood samples were drawn after an overnight fasting before administration of thyroxine tablets. All participants had an initial one-to-one consultation with a clinical dietician, and then followed a

normal-calorie diet. Energy needs were estimated using the Mifflin-St Jeor equation [21]. In energy terms, the diet comprised 55% carbohydrate, 30% fat, and 15% protein.

Statistical analysis

The Statistical analyses were performed with SPSS software (version 29; SPSS, Chicago, IL, USA). Data were quoted as the mean ± standard deviation (SD). Changes in clinical and biochemical variables between baseline and at the end of the intervention were assessed in a paired *t*-test. Pearson correlation was calculated for the correlation between two quantitative variables with its t-test for testing the significance of correlation. The threshold for statistical significance was set to $p < 0.05$.

Results

A total of 42 hypothyroid patients with obesity (5 males and 37 females), mean age (32.5 ± 11 years), with a mean BMI of (38.2 ± 5) kg/m^2 were included in the study. The demographic and clinical characteristics of the participants are summarized in Table 1.

At the end of the 3-month diet program, all the participants presented a substantial body weight loss (mean ± value: 11± 2.6 kg, $p < 0.0001$) with weight reduction percentage (11.5±2.8%, $p< 0.0001$) (figure 1, 2). This was mainly due to fat mass loss (mean loss: 8.6 kg, $p < 0.0001$). The mean BMI was 38.2 ± 5 kg/m^2 before the program and 33.8 ± 5 kg/m afterwards ($p < 0.0001$) (Table 2).

Table 1: Participants' clinical and biochemical characteristics

Number	42
Gender (M/F)	5/37
Age (years)	32.5±11
Body weight (kg)	96.3±12
Mean BMI (kg/m^2)	38.2±5
Body fat (%)	48.2±5.8
Fat mass (kg)	46.5±8.6
Lean mass (fat free mass) (kg)	49.9±7.9
TSH (mUI/L) (N: 0.38- 4.31)	3.06±1.81
Total T3 (nmol/L) (N: 1.22- 2.43)	2.02±0.22
Total T4 (nmol/L) (N: 63.2- 141.9)	93.82±20.81

All values expressed as mean ± SD.

Table 2: Anthropometric, body composition and hormonal data before and after diet program intervention

variable	Baseline	Post intervention	*p*-value
number	42	42	-
Gender (M/F)	5/37	5/37	-
Age (years)	32.5±11	32.5±11	-
Body weight (kg)	96.3±12	85.3±11	0.0001^
Mean BMI (kg/m^2)	38.2±5	33.8±5	0.0001^
Body fat (%)	48.2±5.8	44.1±7.4	0.0001^
Fat mass (kg)	46.5±8.6	37.8±8.9	0.0001^
Lean mass (fat free mass) (kg)	49.9±7.9	47.6±8	0.0001^
TSH (mUI/L) (N: 0.38-4.31)	3.06±1.81	2.52±1.79	0.0001^
Total T3 (nmol/L) (N: 1.22- 2.43)	2.02±0.22	1.43±0.22	0.0001^
Total T4 (nmol/L) (N: 63.2- 141.9)	93.82±20.81	93.99±20.82	0.776

#Significant difference between two dependent means using Paired-t-test at 0.05 level.

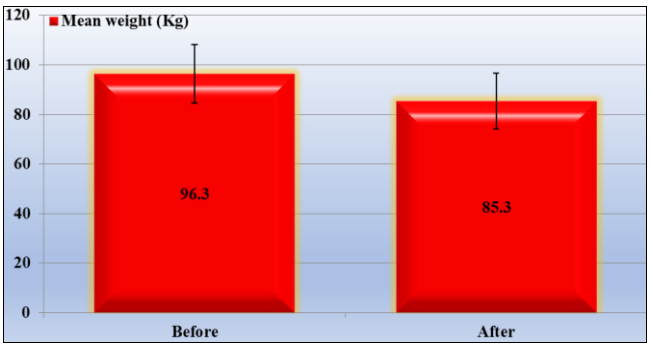

Fig 1: Mean weight loss (kg)

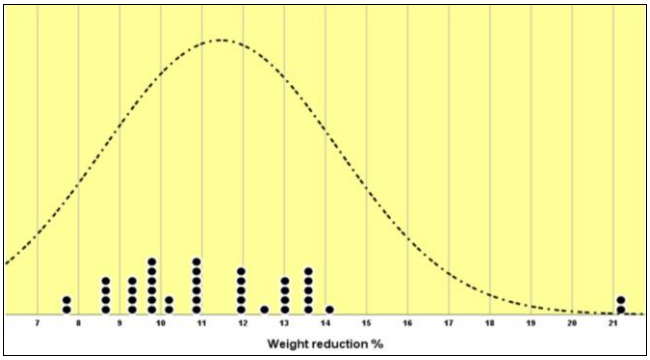

Fig 2: weight reduction percentage

Compared to baseline, after 3-months weight loss intervention, T3, TSH decreased significantly (from 2.02±0.22 to 1.43±0.22, $p < 0.0001$ and from 3.06±1.81 to 2.52±1.79, $p < 0.0001$) respectively; in the absence of significant change in T4 (Table 2).

The weight loss at the end of the intervention was not significantly correlation with the concentrations of TSH ($r = -0.08$, $P = 0.59$), T3 ($r = 0.09$; $P = 0.55$); whereas it was significantly correlated with T4 ($r = -0.37$, $P = 0.01$). Also, there were no significant correlations between the change in fat mass and the concentrations of TSH ($r = 0.02$; $P = 0.87$), T3 ($r = -0.28$, $P = 0.06$) or T4 ($r = 0.25$, $P = 0.10$) (Table 3).

Tabe 3: correlations between thyroid hormones and body compositions with weight reduction percent and fat mass reduction

		Weight reduction%	fat mass reduction
Weight after (Kg)	r	-0.408**	0.726**
	P	0.007	0.0001
Weight reduction Percentage	r	-	-0.421**
	P	-	0.006
BMI after (Kg/m2)	r	-0.444**	0.919**
	P	0.003	0.0001
Fat after (%)	r	-0.312*	0.831**
	P	0.044	0.0001
Fat mass after	r	-0.421**	-
	P	0.006	-
Lean mass after	r	-0.106	-0.106
	P	0.506	0.503
TSH after (mIU/L)	r	-0.084	0.024
	P	0.598	0.879
T3 after (nmol/L)	r	0.094	-0.283
	P	0.554	0.069
T4 after (nmol/L)	r	-0.372*	0.255
	P	0.015	0.103

*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level

Discussion

There is a growing attention has focused on the ability of weight loss to restore thyroid function parameters in obesity. The present study generated important findings, that thyroid function (TSH, T3) change significantly over the course of the intervention, in association with significant weight loss and a fall in BMI. This finding is in agreement with Marzullo *et al*.'s report that weight loss during a 4-week inpatient dieting program was associated with significantly falls in levels of TSH (6.3%), FT3 (3.3%) and FT4 (3.9%; $p < 0.001$ for all) in 70 patients with obesity [22]. It is important to note that the significant body weight loss and fat loss (with mean values of 11 kg and 8.7 kg, respectively) observed in the present study were associated with improved body composition. Furthermore, we also observed a moderate but significant decrease in the lean mass (mean value: 2.3 kg).

Thyroid hormones action plays a pervasive role in the regulation of energy expenditure by its direct stimulation of REE [23]. And the modulation of the metabolism of skeletal muscle, myocardium, and liver synthetic function [22-26]. On the other hand, the hypothalamus pituitary thyroid axis is directly affected by drastic changes in energy stores. Hence, thyroid hormones concentrations reflect, to a certain degree, the overall energy status of the organism. Our weight-loss intervention resulted in a significant decrease in T3, and TSH with no significant changes in T4. Collectively, these observations indicate that even a moderate weight-loss intervention generates a perturbation in hypothalamus pituitary thyroid axis.

The present study had a number of strengths – notably its prospective and longitudinal design. Also the study personnel supervised the protocol rigorously; and ensured that patients complied with the dietary recommendations. This close supervision enabled us to reliably evaluate changes over time, with each participant. Our study also had some limitations; we did not measure the level of hormones or peptides that can be influenced by a weight change (e.g. leptin and ghrelin). Although leptin and TSH levels are reportedly correlated in people with obesity [11], this relationship is subject to debate [8, 27].

Conclusion

our results showed that a 3-month individualized diet program enhanced weight loss with inducing significant changes in TSH, T3 without significant change in T4 in patients with obesity and hypothyroid.

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