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Original Article

# Thyroid hormones, lipid profile and anthropometric changes after programmed weight loss in Palestinian obese adult females

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ABSTRACT

*Objective:* we aimed to investigate the changes in thyroid hormones, lipid profile and anthropometric measures after programmed weight loss in Palestinian obese adult females

*Materials and methods:* This prospective study included 94 obese female (20–50 years old) as cases and 94 Non-obese of same age as controls for baseline comparisons. Obese female were assigned for low calorie diet (1200–1500 Kcal/day) in addition to a daily program of therapeutic exercise for six month. Parameters were measured, statistically analyzed and compared with control before and after study.

*Results:* baseline measurements showed significant differences between cases and control regarding BMI, TG, TC, LDL-C, TSH, T3 and T4. After six months of low calorie diet and exercise there was a significant decrease in BMI, TC, TG and LDL-C in cases as compared to their levels before the study ($P \leq 0.05$). TSH was significantly increased, while, T3 and T4 were significantly decreased in the cases as compared to their levels before the study. Statistically significant correlations were reported between different parameters of the study.

*Conclusions:* Low calorie diet and moderate intensity therapeutic exercise significantly improved the deteriorated health indicators in the cases which justifies the necessity for introducing such low calorie diet coupled with moderate exercise



## 1. Introduction

Obesity is considered a worldwide health problem, with rising prevalence of overweight and obesity in both developing and developed countries [1]. The increasing prevalence of obesity has been also reported in Palestine [2] in general and Gaza strip in particular [3]. Thyroid hormones (TH) act on several aspects of metabolic and energy homeostasis influencing body weight, thermogenesis, and lipolysis in adipose tissue, in addition, it is one of the conventional risk factors for cardiovascular disease (CVD), hypertension, diabetes, hyperlipidaemia and various endocrine disorders [4]. Thyroid hormones play a key role in regulating metabolism through the modulation of thermogenesis and energy expenditure. The relationships between thyroid stimulating hormone (TSH), TH levels, body weight, and adipose tissue homeostasis have been the focus in several studies, but it is still not completely understood [5–7]. A dietary regimen that induces weight loss but maintains proper nutrition remains the most effective nutritional intervention. Several observational studies have suggested that dairy food may facilitate weight loss, particularly in people with obesity and overweight individuals [8,9]. After weight loss, TSH, triiodothyronine ($T_3$), and thyroxine ($T_4$), have been described to either increase or decrease [10,11]. Exercise affects the activity of many glands and the production of their hormones. One of the glands affected is the thyroid [12,13]. In this study, we aimed to evaluate the alterations in TSH, $T_3$, $T_4$, BMI and lipid profiles before and after weight loss, based on low calorie diet and moderate intensity therapeutic exercise among Palestinian obese females. To the best of our knowledge, after searching published scientific works, the present work could be the first that directly investigates the association of thyroid hormones, lipid profile and anthropometric changes after programmed weight loss in obese Palestinian adult females

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## 2. Materials and methods

### 2.1. Study population and experimental design

This prospective study includes 188 samples based on evaluation of obesity among adult females aged (18–50) years in Gaza strip. Cases comprised 94 obese female with BMI >30 kg/m$^2$ and equal number normal weigh apparently healthy female with BMI 18.5-24.9 kg/m$^2$ as a control group for baseline comparisons. Obese females were maintained on low calorie diet (1200–1500 Kcal) and therapeutic exercise on electrical treadmill (motorized 2.5 horses, made in Taiwan, 2004). The subjects performed these daily exercises for six month. For all subjects BMI was calculated and blood samples were withdrawn from cases before and after the study. The study was conducted at private nutritional centers and clinical nutritional center at the main general hospitals in Gaza strip during the period from October 2015 to November 2016. Exclusion criteria included pregnant women and females who had chronic illness or those who are receiving special medical treatments. For ethical consideration, the necessary approval to conduct this study was obtained from Helsinki committee with ethical approval number PHRC/HC/30/15 in the Gaza Strip and all study participants signed the informed consent form of the study.

### 2.2. Specimen collection and processing

Blood collected in a lavender top tube (EDTA and serum). Whole blood collected and tested during 2 h. Serum was separated by centrifugation of whole blood for 10 min at 2500 rpm, the separated samples were frozen at −20 °C. Allow sample tubes to reach room temperature (15–30 °C) before performing the assay.

### 2.3. Biochemical analysis

Cholesterol and triglycerides were determined by enzymatic colorimetric method [14,15] while liquid HDL-C precipitant for the determination of HDL-C [16]. TSH, $T_3$ and $T_4$ concentration were determined using enzyme-linked immunosorbent assay (ELISA) [17].

**Data analysis:** Data were tabulated, encoded and statistically analyzed using the IBM SPSS software version 21.0 for windows (Statistical Package for the Social Sciences Inc, Chicago, Illinois). Means compared by independent-samples *t*-test, and percentage change was also calculated. *P*-value < 0.05 was considered as statistically significant cutoff.

**Table 1**
Socio-demographic characteristics of the study population.

| Character | Non-Obese female | | Obese female | | Chi Square | P-value |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | | |
| **Age (Year)** | | | | | 0.366 | 0.833 |
| 20–30 | 35 | 37.2 | 39 | 41.5 | | |
| 31–40 | 37 | 39.4 | 34 | 36.2 | | |
| 41–50 | 22 | 23.4 | 21 | 22.3 | | |
| Mean ± SD | (33.26 ± 7.8) | | (30.12 ± 9.3) | | | |
| **Marital status** | | | | | 6.805 | 0.009 |
| Single | 18 | 19.1 | 34 | 36.2 | | |
| Married | 76 | 80.9 | 60 | 63.8 | | |
| **Education** | | | | | 18.7 | 0.001 |
| Primary | 6 | 6.4 | 19 | 20.2 | | |
| Secondary | 30 | 31.9 | 45 | 47.9 | | |
| University or Diploma | 58 | 61.7 | 30 | 31.9 | | |

Each reading represents Mean ±SD of 94 subjects
The significant of difference was checked by one-way ANOVA test (compare all vs. control), significant at $P \leq 0.05$.

## 3. Results

Table 1 shows the general socio-demographic characteristics of the study population with no significant differences between obese and non-obese females in either group. The age of the study population ranged from 20 to 50 years with mean of (30.12 ± 9.3) for obese females and (33.26 ± 7.8) for non-obese females ($\chi^2$ = 0.366 and *P* = 0.833). As indicated in Table 2, BMI in obese females was significantly higher compared to non-obese females (38.5 ± 7.2 vs 23.4 ± 1.0, *P* = 0.001). Table 3 illustrates that cholesterol, triglyceride and low-density lipoprotein (LDL-C) were significantly increased in obese compared to non-obese females ($P \leq 0.05$). The mean level of TSH was significantly decreased, while significant increase in the mean levels of $T_3$ and $T_4$ in obese compared to non-obese females ($P \leq 0.05$) Table 4.

After six month of low calorie diet and the exercise program (Tables 2–4), the body mass index in obese females were significantly lower after weight loss compared to their levels before the study (23.5 ± 1.0 vs 38.5 ± 7.2 respectively, with% change = −39, *P* = 0.001). The mean levels of cholesterol, triglyceride and low-density lipoprotein were significantly decreased in obese females after weight loss compared to their levels before the study (163.5 ± 14.81, 124.9 ± 25.4 and 96.9 ± 10.7 vs 186.4 ± 29.78, 153.4 ± 34.8 and 124.3 ± 28.23, respectively, $P \leq 0.05$). TSH level in obese females were significantly increased after weight loss compared to the mean before weight loss (3.2 ± 1.7 vs 2.05 ± 0.6, % change 56.1, $P \leq 0.05$). In contrast, the levels of $T_3$ and $T_4$ were significantly decreased in obese females after weight loss compared to their levels before the study (1.03 ± 0.33 and 7.4 ± 1.30 vs 1.36 ± 0.24 ng/ml and 8.77 ± 1.67 respectively, $P \leq 0.05$).

Analyses using the Pearson correlation coefficient revealed significant correlations between BMI, TSH and $T_3$ with study parameters shown in Table 5. Among these important correlations are the positive correlation that reported between BMI with cholesterol, triglyceride and LDL-C and a negative correlation with TSH ($P \leq 0.01$). Statistically significant negative correlation between TSH with $T_3$, $T_4$ triglyceride, and LDL-C (r = −0.509, −0.456, −0.186 and −0.219, $P \leq 0.01$) were also reported. In addition, $T_3$ showed strong positive correlation with $T_4$ (r = 0.8, *P* = 0.001) (Fig. 1).

## 4. Discussion

Thyroid hormones regulate the rate of metabolism and affect the growth rate, maintenance of body weight, rate of energy use from blood glucose and heart rate [18]. It influence key metabolic pathways which control energy balance by regulating energy storage and expenditure [19]. Changes in thyroid hormone concentrations may be regarded as an adaptation process in weight change. Recent studies have shown that changes in thyroid hormone levels, even within the physiological ranges, may contribute to the deteriorating of atherogenic lipid profile [20–22]. The main objective was to study the changes in thyroid hormones, lipid profile and anthropometric measures after programmed weight loss in Palestinian obese adult females.

Our results revealed that the body mass index in obese females were significantly lower after six month of low calorie diet and the exercise program, compared to their levels before the study. These results were coinciding with the results of Klijn et al., from the Netherlands [23]. Caloric balance is one of the most important factors that relates to obesity. Overweight and obese results from an energy imbalance caused by eating too many calories and not getting enough exercise. The effects of exercise can add to dietary interventions to enhance loss of fat mass and improve long-term maintenance [24]. The mean levels of cholesterol, triglyceride and

**Table 2**
Anthropometric measurements before and after weight loss.

| Anthropometric measurement | Non-Obese female | Obese female | | % Change | t-value | P-value |
|---|---|---|---|---|---|---|
| | | Before weight loss | After weight loss | | | |
| **Weight (kg)** | $73.1 \pm 5.2$ | $85.6 \pm 12.2$[a] | $75.1 \pm 5.1$[b] | −12.3 | 2.52 | 0.021 |
| **Height (m)** | $1.56 \pm 0.07$ | $1.6 \pm 0.06$[a] | $1.6 \pm 0.06$ | – | −0.56 | 0.581 |
| **BMI** | $23.4 \pm 1.0$ | $38.5 \pm 7.2$[a] | $23.5 \pm 1.0$[b] | −39 | 6.53 | 0.001 |

Kg: kilogram, m: meter, BMI: Body mass index: People with BMI = 18.5.24.9 were considered to have normal weight and people with BMI $\geq$ 30.0 were classified obese (WHO, 2000)
Each reading represents Mean ±SD of 94 subjects.
[a] The significant of difference was checked by one-way ANOVA test (compare all vs. control), significant at $P \leq 0.05$.
[b] The difference in obese before and after weight loss were checked by one-way ANOVA was significant at P $\leq$ 0.05.

**Table 3**
Lipid profile before and after weight loss.

| Parameter | Non-Obese female | Obese female | | % Change | t-value | P-value |
|---|---|---|---|---|---|---|
| | | Before weight loss | After weight loss | | | |
| Cholesterol (mg/dl) | $170.4 \pm 16.6$ | $186.4 \pm 29.78$[a] | $163.5 \pm 14.81$[b] | −12.3 | 2.17 | 0.043 |
| Triglyceride (mg/dl) | $138.7 \pm 23.6$ | $153.4 \pm 34.8$[a] | $124.9 \pm 25.4$[b] | −18 | 2.09 | 0.050 |
| LDL-C (mg/dl) | $102.5 \pm 17.6$ | $124.3 \pm 28.23$[a] | $96.9 \pm 10.7$[b] | −22 | 2.87 | 0.010 |
| HDL-C (mg/dl) | $41.2 \pm 4.4$ | $42.7 \pm 6.33$ | $42.6 \pm 4.93$ | −0.23 | 0.39 | 0.969 |

LDL-C: Low density lipoprotein cholesterol, HDL-C: High-density lipoprotein cholesterol.
Each reading represents Mean ±SD of 94 subjects.
[a] The significant of difference was checked by one-way ANOVA test (compare all vs. control), significant at $P \leq 0.05$.
[b] The difference in obese before and after weight loss were checked by one-way ANOVA was significant at P $\leq$ 0.05.

**Table 4**
TSH and thyroid hormones levels before and after weight loss.

| Parameter | Non-Obese female | Obese female | | % change | t-value | P-value |
|---|---|---|---|---|---|---|
| | | Before weight loss | After weight loss | | | |
| **TSH (µIU/ml)** | $3.23 \pm 1.18$ | $2.05 \pm 0.6$[a] | $3.2 \pm 1.7$[b] | 56.1 | −2.04 | 0.050 |
| **$T_3$ (ng/ml)** | $1.20 \pm 0.29$ | $1.36 \pm 0.24$[a] | $1.03 \pm 0.33$[b] | −24.3 | 2.55 | 0.020 |
| **$T_4$ (µg/dl)** | $8.31 \pm 1.49$ | $8.77 \pm 1.67$[a] | $7.4 \pm 1.30$[b] | −15.6 | 2.03 | 0.050 |

TSH: Thyroid stimulating hormone, $T_3$: Triiodothyronine hormone, $T_4$: Thyroxin hormone.
Each reading represents Mean ±SD of 94 subjects.
[a] The significant of difference was checked by one-way ANOVA test (compare all vs. control), significant at $P \leq 0.05$.
[b] The difference in obese before and after weight loss were checked by one-way ANOVA was significant at P $\leq$ 0.05.

**Table 5**
The correlation of BMI, TSH and T3 with study parameters.

| Parameters | BMI (Kg/m$^2$) | |
|---|---|---|
| | Pearson correlation (r) | *P*-value |
| **TSH** | −0.323** | 0.001 |
| **TC** | 0.318** | 0.001 |
| **TG** | 0.178* | 0.014 |
| **LDL-C** | 0.270** | 0.001 |
| **TSH** | | |
| **$T_3$** | −0.509** | 0.001 |
| **$T_4$** | −0.456** | 0.001 |
| **TG** | −0.186* | 0.011 |
| **LDL-C** | −0.219** | 0.003 |
| **T3** | | |
| **$T_4$** | 0.815** | 0.001 |
| **LDL-C** | 0.147* | 0.044 |

TSH: Thyroid stimulating hormone, $T_3$: Triiodothyronine hormone, $T_4$: Thyroxin hormone, TC: cholesterol, TG: Triglyceride, LDL-C: Low-density lipoprotein cholesterol.
*Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed).

low-density lipoprotein were significantly decrease in obese females after programmed weight loss compared to their levels before the study. These results were in agreement with the Indian study performed in 2012 by Dipankar et al., [25]. The most significant contributing factor for obesity-related dyslipidemia is enhanced utilization of lipid substrates; increase in synthesis and mobilization of triglyceride stored in adipose tissue; uncontrolled fatty acid release from adipose tissue through lipolysis which causes increased delivery of fatty acids to the liver and synthesis of very-low-density lipoprotein (VLDL) [26]. Our results revealed a significant positive correlation of BMI with cholesterol, triglyceride and LDL-C and a negative correlation with TSH. Our results were concomitant with other findings from other populations [20,27]. TSH level in obese females were significantly increase and significant decrease in the mean levels of $T_3$ and $T_4$ after programmed weight loss compared. Our findings were in agreement with [28,29]. As the thyroid hormones especially $T_3$ regulate both the resting metabolic rate and thermogenesis and lead to lipolysis, changes in thyroid hormones could also point to an adaptation process in obesity [30]. When the peripheral thyroid hormones decrease after a reduction of overweight, we can also expect a reduction in resting metabolic rate and consequently a reduction in energy expenditure [31]. These findings may reflect the accumulated physical stress and may be due to increased action of the plasma catecholamines that known to potentiate actions of thyroid hormones [32].

The results showed significant negative correlation between TSH with $T_3$ and $T_4$. Similar results were reported in Iran study performed in 2013 by Dorgalaleh et al., [33]. The hypothalamus

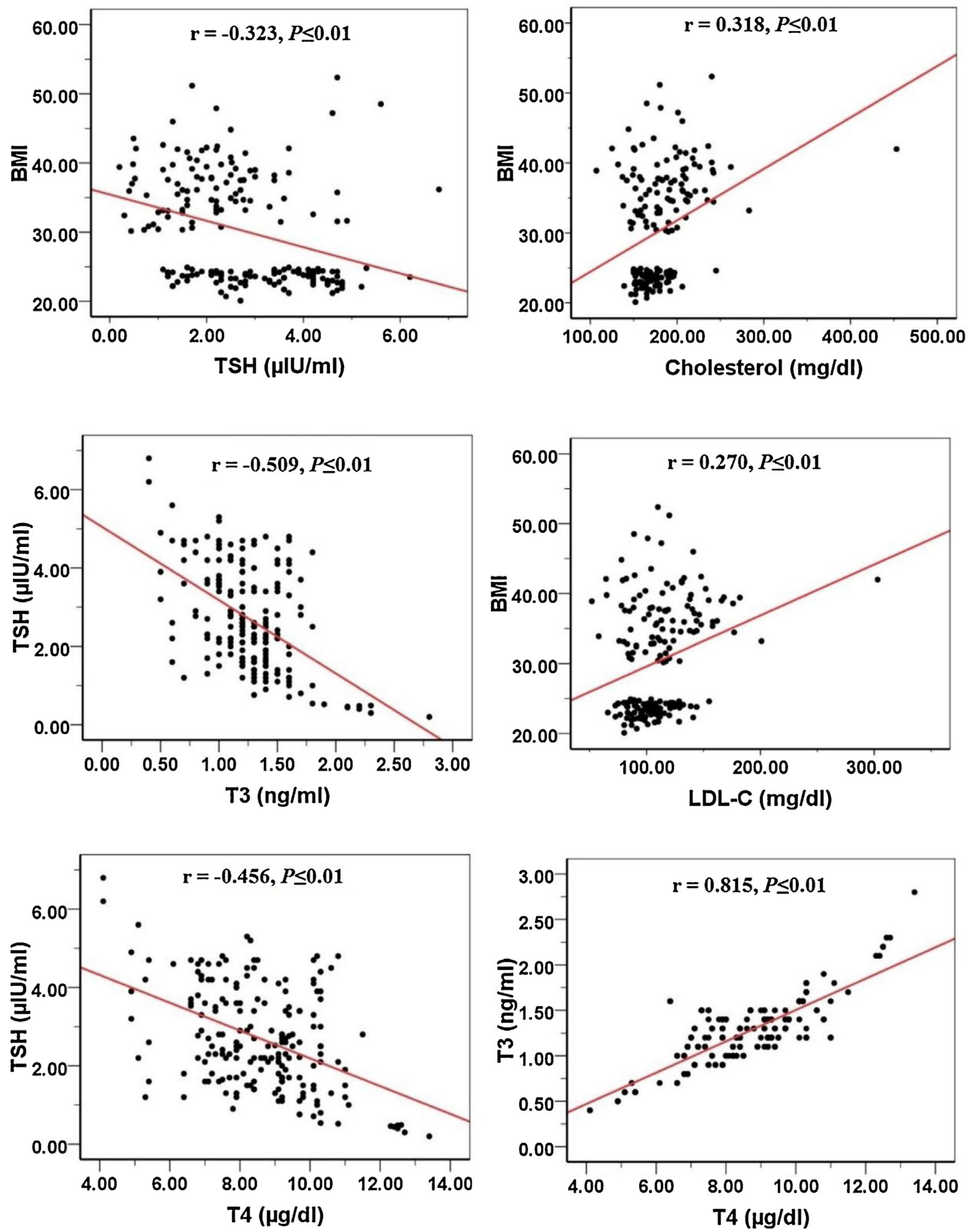


**Fig. 1.** Pearson correlation coefficient analysis of BMI, TSH and $T_3$ with study parameters.

senses low circulating levels of thyroid hormones $T_3$ and $T_4$ and responds by releasing TRH. The TRH stimulates the pituitary to produce TSH. The TSH, in turn, stimulates the thyroid to produce thyroid hormone (TH) until levels in the blood return to normal. TH exerts negative feedback control over the hypothalamus as well as anterior pituitary, thus controlling the release of both TRH from hypothalamus and TSH from anterior pituitary gland [34]. This negative correlation may be explained on the basis that increase in TSH may be due to decrease in TH, which consequently increase the concentrations of TC, phospholipids, and TG in plasma. In addition, strong positive significant correlations between $T_3$ with $T_4$ level. $T_3$ is several times more powerful than $T_4$, which is largely a prohormone, perhaps four or even ten times more active [30]. These hormones regulate the rate of metabolism and affect the growth and rate of function of many other systems in the body, including maintenance of body weight, rate of energy use from blood glucose and heart rate [18]. $T_3$ showed significant positive correlations with LDL-C. Similar results [35]. $T_3$ is the biologically active hormone in the tissues. TH, especially $T_3$, induce LDL-C receptor gene expression in the liver, enhancing LDL-C clearance and explaining the decreased or increased LDL-C levels observed in hyperthyroidism and hypothyroidism, respectively [36].

### 4.1. Conclusions and recommendations

Body mass index, cholesterol, triglyceride, low-density lipoprotein, $T_3$ and $T_4$ in obese females were significantly lower while TSH level were increase after weight loss compared to the mean before weight loss after programmed weight loos compared to their levels before the study. BMI showed positive correlation with cholesterol, triglyceride and LDL-C and a negative correlation with TSH. Negative correlation found between TSH with $T_3$, $T_4$ triglyceride, and LDL-C. While, $T_3$ showed strong positive correlation with $T_4$. Several drugs are available for weight loss however, they cause side effects. Normal energy diet accompanied with exercise induces a long-term decrease lipid profile, $T_3$ & $T_4$ and enhances TSH levels. Exercise is very effective, and an individualized diet program help prevent complications of obesity. Physiological alterations seem to be improve programmed weight loos and therefore no treatment were needed.

## Conflicts of interest

The authors declare no conflicts of interest.

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## Author contributions

All authors were involved in writing, reading and approved the manuscript.

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