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Effect of Thyroid Hormones and Trace Elements (Zn, Mg) on Obesity

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Abstract

Background: Obesity is characterized by abnormal or excessive fat accumulation that is the result of a chronic imbalance between energy intake and energy expenditure. Thyroid hormones have profound effect on many physiological processes, such as development, growth in children and metabolism. Thyroid hormones stimulate diverse metabolic activates in most tissues, leading to an increase in basal metabolic rate. Trace elements are essential nutrients with regulatory, immunologic, and antioxidant functions resulting from their action as essential components or cofactors of enzymes throughout metabolism.

Methods: In this study conducted on 176 individuals in the age group from (20-55) years, from Tikrit and Kirkuk Governorates. Blood samples were divided into three groups according to BMI: Group One: Control group (Normal Weight): 66 individual BMI (18.5 - 24.9 kg/m^2). Group Two: Overweight group: 50 individual BMI (25.0 – 29.9 kg/m^2).Group Three: Obese group: 60 individual BMI (≥ 30 kg/m^2).

Results: The results showed a high significant increase ($p<0.0001$) in the BMI level in obese and overweight groups comparison with normal weight group. The results showed a significant decrease ($p<0.001$) in (T3 and T4) hormones levels in obese and overweight groups comparison with normal weight group. While the results showed a high significant increase ($p<0.0001$) in the TSH levels in obese and overweight groups comparison with normal weight group, the results showed a significant decrease ($p<0.001$) in the Zn concentration in obese and overweight groups comparison with normal weight group, the results showed a high significant decrease ($p<0.0001$) in the Mg concentration in obese and overweight groups comparison with normal weight group. There is a high significant increase in the (cholesterol, TG, VLDL-c and LDL-c) levels in obese and overweight groups comparison with normal weight group ($p<0.0001$), while the results showed a high significant decrease ($p<0.0001$) in the HDL-c level in obese and overweight groups comparison with normal weight group. The results showed that there was a significant positive correlation between T3 and T4.While there was a significant negative correlation between T3 and LDL. There was a positive correlation between T4 and HDL. Whereas the there was a significant negative correlation between T4 and LDL. There was a significant positive correlation between TSH with Cholesterol, Triglyceride, LDL and VLDL. There was a significant negative correlation between TSH with HDL, and Mg. **Conclusions**: The results of (thyroid hormones and lipid profile) indicated highly associated with trace elements (Zn, Mg) levels and these correlations may be caused a risk of the obesity.

Keywords: Thyroid hormones, Trace elements (Zinc, Magnesium), BMI, Lipid profile, Obesity.

Introduction

Obesity has become a major global health challenge. It is influenced by various factors, including genetics, variations in nutrient intake, behavioral and environmental factors [1]. However, in obesity, there is an imbalance in adipokines production, a fact which, together with the inability to store fat in the adipocytes, results in a process of adipose tissue dysfunction [2], a known risk factor for developing obesity-associated metabolic disorders [2-4]. Thyroid hormone plays a critical role in the development and function of virtually every organ system in humans, this process is stimulated by TSH. The anterior pituitary releases TSH in response to thyroid-releasing hormone, which is secreted by the hypothalamus. The thyroid gland secretes both thyroxine (T4) and triiodothyronine (T3), which exerts a negative feedback on TSH releasing hormone and TSH secretion [5, 6]. Interest in trace elements has been steadily increasing over the last 25 years. Trace elements are essential nutrients with regulatory, immunologic, and antioxidant functions resulting from their action as essential components or cofactors of enzymes throughout metabolism [7]. The determination of trace elements in the blood is of increasing interest in many clinical and research laboratories due to their role in maintenance of health and development of optimal physiological function [8]. The role of Zn in carbohydrate metabolism is complex. Zinc plays an important role in synthesis, storage and release of insulin [9]. This element affects the functioning of the beta cells in the islets of Langerhans. Animal research shows that Zn administered in small doses protects against type 2 diabetes but a high concentration of the element is toxic to the beta cells in the islets of Langerhans [10]. This mineral participates in the metabolism of hormones involved in the physiopathology of the obesity, such as insulin, and the thyroid hormones [11,12]. Magnesium acts as a co-factor in the regulation of various ATP-requiring enzymes, many of which are implicated in glucose metabolism [13]. It also regulates cholesterol synthesis and lipid homeostasis by controlling the activity of lecithin cholesterol acyltransferase and LPL both of which are required to increase HDL [14]. Magnesium is also essential for maintaining vascular tone, BP [15], calcium, sodium and potassium metabolism [16].

The aim of this study was to determine thyroid hormones in the obesity and study the relationship of them with trace elements (Zn, Mg) and lipid profile.

Methods

This study was conducted on 176 individuals in the age group of (20-55) years. All individuals were

randomly taken from Tikrit and Kirkuk Governorates. Blood samples were divided into three groups according to BMI: Group One: Control group (Normal Weight): 66 individual BMI (18.5 - 24.9 kg/m^2). Group Two: Overweight group: 50 individual BMI (25.0 – 29.9 kg/m^2).Group Three: Obese group: 60 individual BMI (≥ 30 kg/m^2). About 5 ml of venous blood were withdrawn from (obese individuals, over weight individuals and controls) using a disposable syringe after 12-hour fasting. The collected blood was then allowed to clot in a plain tube at room temperature, after which the serum was separated by centrifugation at 3000 rpm for 10 min, and kept frozen at -20 °C to be analyzed later on. Serum T3 [17], serum T4 [18] and serum TSH [19] were measured by ELISA. Serum Zn [20], serum Mg [21] and lipid profile [22-26] were measured by spectrophotometer. Statistical analysis was performed by statisticians with the SPSS 15.01 Statistical Package for Social Sciences and also Excel 2003. Data analysis was done using chi- square test for tables with frequencies, while independent sample t-test was used for tables with means and standard Deviation. P value of ≤ 0.05 was used as the level of significance. Correlation coefficient used to find the correlation between studied markers by using Pearson correlation.

Results

This study included 3 groups: Obese, Overweight and Normal weight (Control). The results showed a high significant increase (p<0.0001) in the BMI levels in obese and overweight groups comparison with normal weight group, and the Mean± SD of BMI was (34.867±3.538), (27.684±1.473), and (22.440±1.478) kg/m^2, respectively, as shown in (Table 1) (Figure 1). the results showed a significant decrease (p<0.001) in the T3 hormone concentration in obese and overweight groups in comparison with normal weight group, and the mean±SD of T3 hormone was (0.9292±0.1996), (1.0184±0.1992), and (1.1982±0.2430) ng/ml, respectively, as shown in (Table1) (Figure2). the results showed a significant decrease (p<0.001) in the T4 hormone concentration in obese and overweight groups in comparison with normal weight group, and the mean±SD of T4 hormone was (5.683±1.318), (6.642±1.447), and (7.911±1.125)µg/dl, respectively, as shown in (Table 1) (Figure 3). the results showed a high significant increase (p<0.0001) in the TSH concentration in obese and overweight groups in comparison with normal weight group, and the mean±SD of TSH hormone was (2.6970±0.6232), (2.0516±0.5551), and (1.5857±0.5113) µIU/ml, respectively, as shown in (Table 1) (Figure 4). The results showed a significant decrease (p<0.001) in Zn concentration in obese and overweight groups in comparison with normal weight group, and the mean±SD of Zn was (121.15±7.93), (122.76±9.63), and (130.61±10.77) µg/dl, respectively, as shown in (Table 1) (Figure 5). The results showed a high significant decrease (p<0.0001) in the Mg concentration in obese and overweight groups in comparison with normal weight group, and the mean±SD of Mg was (1.2091±0.0317), (1.2861±0.0823), and (1.3684±0.0585) mg/dl, respectively, as shown in (Table 1) (Figure 6). There is a high significant increase in the (cholesterol, TG, VLDL and LDL) levels in obese and overweight groups comparison with normal weight group (p<0.0001), as shown in (Table 1), while the results showed a high significant decrease (p<0.0001) in the HDL concentration in obese and overweight groups comparison with normal weight group, as shown in (Table 1) (Figures 7-11).

Table 1: Comparison between Weight Groups and Serum Parameters:

Parameters N.	Normal weight Mean±SD	Overweight Mean±SD	Obese Mean±SD	P value
BMI(kg/m^2)	22.440±1.478	27.684±1.473	34.867±3.538	<0.0001
T3 (ng/ml)	1.1982±0.2430	1.0184±0.1992	0.9292±0.1996	<0.001
T4(µg/dl)	7.911±1.125	6.642±1.447	5.683±1.318	<0.001
TSH(µIU/ml)	1.5857±0.5113	2.0516±0.5551	2.6970±0.6232	<0.0001
Zn(µg/dl)	130.61±10.77	122.76±9.63	121.15±7.93	<0.001
Mg(mg/dl)	1.3684±0.0585	1.2861±0.0823	1.2091±0.0317	<0.0001
Cholesterol (mmol/l)	4.1671±0.7946	5.2258±0.8281	5.9153±1.1027	<0.0001
Triglyceride(mmol/l)	1.6839±0.5763	2.2348±0.6279	2.9202±0.7261	<0.0001
HDL(mmol/l)	2.1476±0.7186	1.5468±0.5548	1.0712±0.2482	<0.0001
LDL(mmol/l)	1.2586±0.6922	2.6686±0.9170	3.5211±1.1815	<0.0001
VLDL(mmol/l)	0.7609±0.2614	1.0104±0.2857	1.3230±0.3305	<0.0001

The results showed that there was a significant positive correlation between T3 and T4 (r=0.390).While the results showed that there was a significant negative correlation between T3 and LDL (r=-0.410), as shown in (Table 2). The results showed that there was a positive correlation between T4 and HDL (r=0.386).Whereas the results showed that there was a significant negative correlation between T4 and LDL (r=-0.424), as shown in (Table 3). The results showed that there was a significant positive correlation between TSH with Cholesterol (r=0.426), Triglyceride (r=0.454), LDL (r=0.501) and VLDL (r=0.454). The results showed that there was a significant negative correlation between TSH with

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HDL (r=-0.471), and Mg (r=-0.438), as shown in (Table 4).

Table 2: Correlations between T3 (ng/ml) and other Parameters

Parameters	(r) value
T4(µg/dl)	0.390
TSH(µIU/ml)	-0.359
Cholesterol(mmol/l)	-0.308
Triglyceride(mmol/l)	-0.239
HDL(mmol/l)	0.378
LDL(mmol/l)	-0.410
VLDL(mmol/l)	-0.238
Zn(µg/dl)	0.171
Mg(mg/dl)	0.300

Table 3: Correlations between T4 (µg/dl) and other Parameters

Parameters	(r) value
TSH(µIU/ml)	-0.350
Cholesterol(mmol/l)	-0.348
Triglyceride(mmol/l)	-0.319
HDL(mmol/l)	0.386
LDL(mmol/l)	-0.424
VLDL(mmol/l)	-0.319
Zn(µg/dl)	0.197
Mg(mg/dl)	0.331

Table 4: Correlation between TSH (µIU/ml) and other Parameters

Parameters	(r) value
Cholesterol(mmol/l)	0.426
Triglyceride(mmol/l)	0.454
HDL(mmol/l)	-0.471
LDL(mmol/l)	0.501
VLDL(mmol/l)	0.454
Zn(µg/dl)	-0.240
Mg(mg/dl)	-0.438

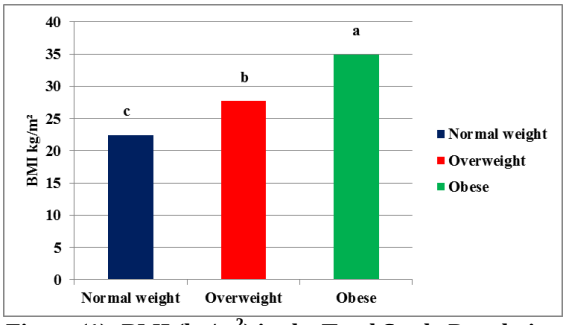

Figure (1): BMI (kg/m^2) in the Total Study Population

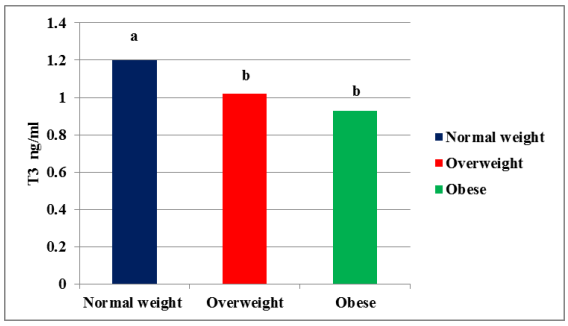

Figure (2): T3 Hormone Concentration in the Total Study Population

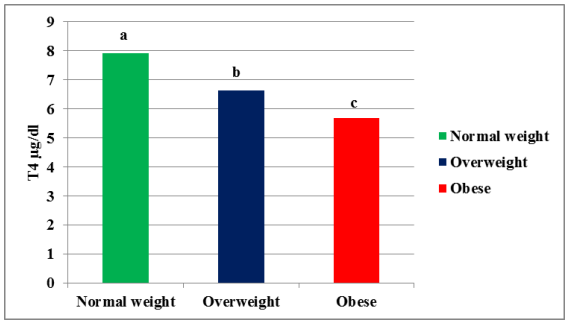

Figure (3): T4 Hormone Concentration in the Total Study Population

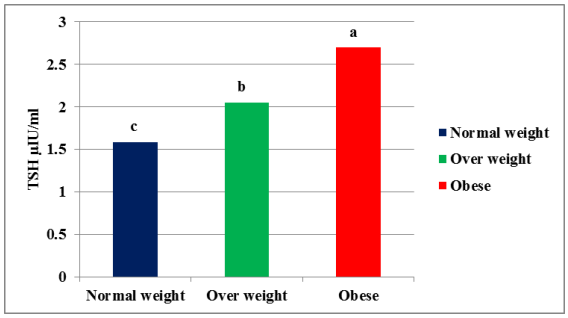

Figure (4): TSH Concentration in the Total Study Population

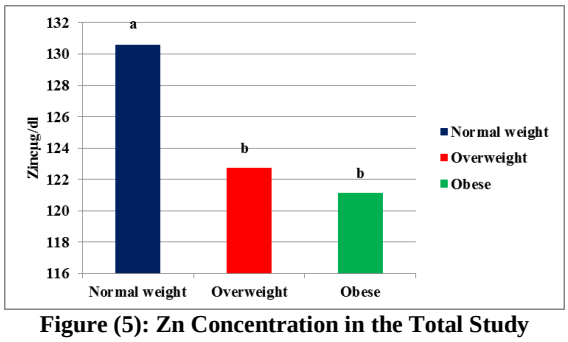

Figure (5): Zn Concentration in the Total Study Population

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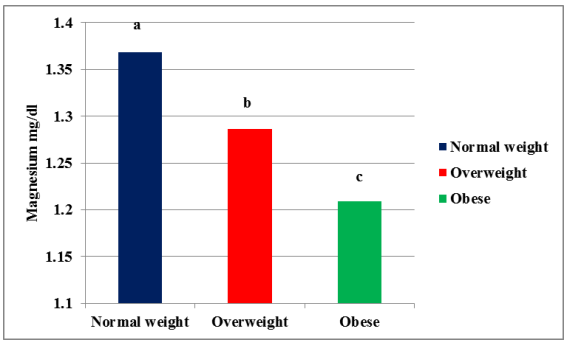

Figure (6): Mg Concentration in the Total Study Population

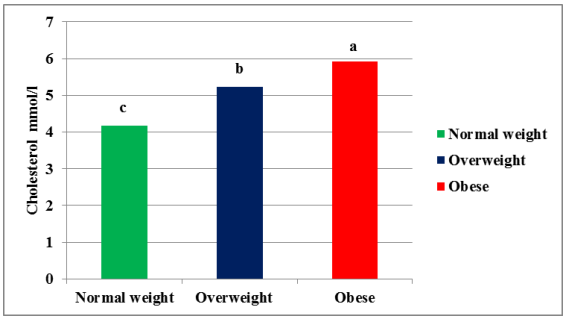

Figure (7): Cholesterol Concentration in the Total Study Population

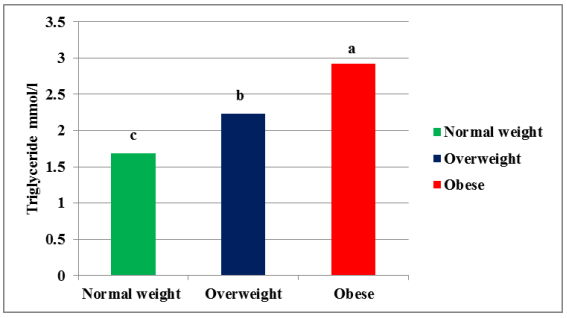

Figure (8): Triglyceride Concentration in the Total Study Population

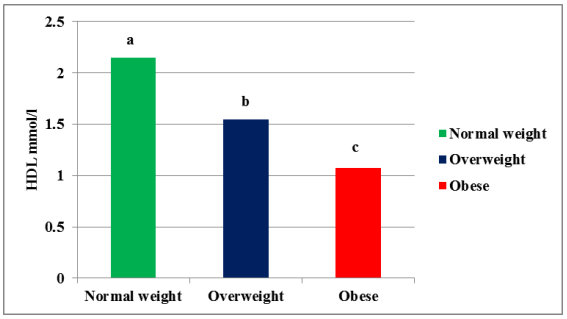

Figure (9): HDL Concentration in the Total Study Population

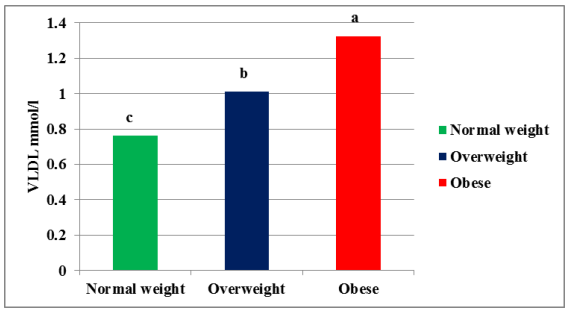

Figure (10): VLDL Concentration in the Total Study Population

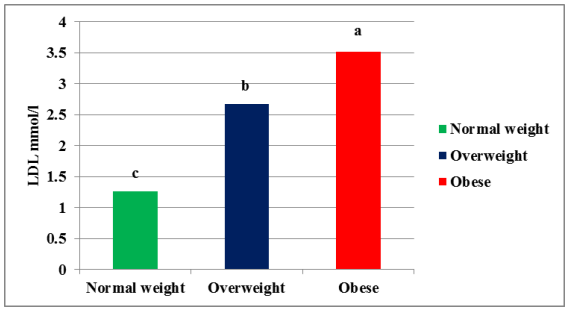

Figure (11): LDL Concentration in the Total Study Population

Discussion

In the presented study, there was a significant decrease in the levels of thyroid hormones (T3, T4) and trace elements (Zn, Mg), and there was a significant increase in the level of TSH in obese and overweight individuals compared to control group. Thyroid hormones play a very important role in controlling the bodys metabolism, that is the rate at which the body uses energy [27], by stimulating divers metabolic activates most tissue, leading to an increase in basal metabolic rate one consequence of this activity is to increase body heat production [28]. Thyroid hormones are important regulatory factors involved in energy balance and adaptive thermogenesis[29,30]; these hormones (T3 triiodothyronine; T4 thyroxine) increase basal metabolic rate and lipolysis, and suppress the thyroid-stimulating hormone (TSH) concentrations [31]. The experimental procedures by which hypothyroidism is induced affect the oxidative stress endings. Hypothyroidism obtained by surgical thyroid resection in rats was associated with decreased oxidative stress in heart [32] and kidney [33].

Increased, decreased, or unmodified levels of total SOD, Mn-SOD, Cu, Zn-SOD, GPx, GSH, or Vitamin E have been reported in cardiomyocytes in response to hypothyroidism[34]. The thyroid itself can be damaged by oxidative stress, which occurs in case of iodine excess. This topic has been studied both *in vitro* and in animals fed with a diet rich in iodide [35]. Similar studies indicate a significantly lower Mg concentration in people with overweight and obesity, and suggest that Mg does not protect against disorders of lipid metabolism but may have a beneficial effect on blood pressure, carbohydrate

metabolism, and reduce the risk of abdominal obesity [36]. Mak *et al* indicate that Mg supplementation improves the lipid profile and thus helps to reduce the risk of cardiovascular disease [37]. Other study predicts that zinc deficiency can be contributed to the morbidity observed within the obese population in that a lack of zinc has the potential to increase inflammation which then may increase the risk of developing inflammation-mediated diseases. If correct, zinc supplementation has the potential to lower the risk of the progression of obesity to cardiovascular diseases [38]. Other study showed on Zn deficiency that there was a significant negative correlation between serum Zn and TC, LDL-c, TG and LDL-c/HDL-c ratio and a significant positive correlation existed between serum Zn and HDL-c in the patient group while the control group showed no such correlation. Therefore, these findings indicate the possible effect of Zn level in serum lipid profile, and this effect may be due to the role of Zn as an antioxidant [39]. Previous studies which showed treatment with Zn reduced TC, TG, and LDL-c plasma levels and increased HDL-c levels [40].

Conclusions

The results showed that there was a significant positive correlation between T3 and T4.While there was a significant negative correlation between T3 and LDL. There was a positive correlation between T4 and HDL. Whereas the there was a significant negative correlation between T4 and LDL. There was a significant positive correlation between TSH with Cholesterol, Triglyceride, LDL and VLDL. There was a significant negative correlation between TSH with HDL, and Mg, these correlations may be caused obesity.

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تأثير هرمونات الغدة الدرقية والعناصر النزرة (الخارصين والمغنيسيوم) على السمنة

شيماء عيسى احمد ، فراس طاهر ماهر ، نزار احمد ناجي

قسم الكيمياء ، كلية العلوم ، جامعة تكريت ، تكريت ، العراق

الملخص

الخلفية: تتميز البدانة بتراكم الدهون الغير طبيعية أو المفرطة التي هي نتيجة لخلل مزمن بين استهلاك الطاقة وصرف الطاقة.هرمونات الغدة الدرقية لها تأثير كبير على العديد من العمليات الفسيولوجية، مثل التطور, ونمو الأطفال والتمثيل الغذائي. هرمونات الغدة الدرقية تعمل على تحفيز العمليات الايضية المتنوعة في معظم أنسجة الجسم، مما يؤدي إلى زيادة في معدل الأيض القلوي. العناصر النزرة هي عبارة عن مواد غذائية أساسية منظمة، ومناعية، وتمتلك وظائف مضادة للأكسدة نتيجة لعملها كمكونات اساسية أو كعوامل مساعدة للانزيمات في العمليات الايضية.

طرق العمل: تضمنت هذه الدراسة 176 شخصا وكانت أعمارهم بين 20–55سنة من محافظتي تكريت وكركوك. تم تقسيم عينات الدم إلى ثلاث مجاميع وفقا لمؤشر كتلة الجسم: المجموعة الأولى: مجموعة السيطرة (الوزن الطبيعي): 66 فرد(32 ذكور، 34 إناث)، مؤشر كتلة الجسم (18،5–24،9 كغم /م^2). المجموعة الثانية: مجموعة الوزن الزائد: 50 فرد (16 ذكور، 34 إناث)، مؤشر كتلة الجسم (25،0–29،9 كغم /م^2). المجموعة الثالثة: مجموعة البدينين: 60 فرد (28 ذكور، 32 إناث)، مؤشر كتلة الجسم (≤ 30 كغم /م^2).

النتائج: أظهرت النتائج زيادة معنوية عالية ($P < 0.0001$) في مستوى مؤشر كتلة الجسم في مجموعة السمنة والوزن الزائد مقارنة مع مجموعة الوزن الطبيعي. أظهرت النتائج انخفاض معنوي ($p < 0.001$) في مستويات هرمونات (T3 و T4) في مجموعة السمنة والوزن الزائد مقارنة مع مجموعة الوزن الطبيعي. في حين أظهرت النتائج زيادة معنوية عالية ($P < 0.0001$) في مستويات TSH في مجموعة السمنة والوزن الزائد مقارنة مع مجموعة الوزن الطبيعي ، أظهرت النتائج انخفاض معنوي ($p < 0.001$) في تركيز الزنك في مجموعة السمنة والوزن الزائد مقارنة مع مجموعة الوزن الطبيعي ، وأظهرت النتائج انخفاضا معنويا ($P < 0.0001$) في تركيز المغنيسيوم في مجموعة السمنة والوزن الزائد مقارنة مع مجموعة الوزن الطبيعي. هناك زيادة معنوية عالية ($P < 0.0001$) في مستويات (الكولسترول، TG، VLDL-c وLDL-c) في مجموعة السمنة والوزن الزائد مقارنة مع مجموعة الوزن الطبيعي ، في حين أظهرت النتائج انخفاضا معنويا ($P < 0.0001$) في مستوى HDL-c في مجموعة السمنة والوزن الزائد مقارنة مع مجموعة الوزن الطبيعي. هناك علاقة ايجابية معنوية بين T3 و T4. وان هناك علاقة سلبية معنوية بين T3 و LDL-c. في حين هناك علاقة ايجابية معنوية بين T4 و LDL-c . وان هناك علاقة سلبية معنوية بين T4 و LDL-c. هناك علاقة ايجابية معنوية بين TSH مع الكولستيرول, الكليسيريدات الثلاثية, LDL-c و, VLDL-c . وان هناك علاقة سلبية معنوية بين TSH مع HDL-c و Mg.

الاستنتاجات: نتائج (هرمونات الغدة الدرقية والدهون) اظهرت ارتباطا معنويا مع مستويات العناصر النزرة (الزنك والمغنسيوم) وهذه الارتباطات ربما تسبب مخاطر السمنة.