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Thyroid function, metabolic parameters and anthropometric changes among Palestinian obese adult females

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ABSTRACT

Objective: We sought to evaluate the associations between thyroid hormones, metabolic parameters and anthropometric changes among Palestinian obese adult females.
Materials and methods: This case-control study included 94 obese and 94 Non-obese female (20–50 years old). Body mass index was determined. Complete blood count, glucose, lipid, protein profile, kidney, liver function, Ca^{2+}, TSH, T_3 and T_4 levels were evaluated.
Results: Significant increase in the BMI of obese females compared to control (37.23 ± 4.7 vs. 23.4 ± 1.03, $P \leq 0.001$). Hb, HCT MCV, MCH and RDW were decreased significantly in cases compared to control ($P \leq 0.001$). The mean levels of TC, TG and LDL-C were significantly increased in cases compared to control ($P \leq 0.01$). TSH was significantly decreased (% difference = -32.984 and $P \leq 0.001$) while, T_3 and T_4 were significantly increased among obese compared to non-obese females (% difference = 9.485 and 6.326, $P < 0.05$, respectively). Statistically significant correlations were reported between different parameters.
Conclusions: Obesity was correlated with thyroid hormones, metabolic parameters and anthropometric changes among Palestinian obese adult females. The levels of cholesterol, triglyceride, LDL-C, T_3 and T_4 increase while TSH were decrease with BMI increase. TSH, T_3 and T_4 are very important tests and frequent monitoring of lipid profile is necessary for obese females. Our findings recommend that obese individuals with relatively higher thyroid hormones, metabolic parameters might benefit more from body weight regulation using a diet intervention strategy for weight loss.

1. Introduction

Obesity is abnormal or excessive fat accumulation that may negatively impacts human health, it is a major public health concern in most developed countries, and in adults is a cause of diseases including cardiovascular diseases (Kumari et al., 2019), type II diabetes (Bukht et al., 2019)and some cancers (Hruby and Hu, 2015). Obesity is a complex, multifactorial disease that develops from the interaction between genotype and the environment (Qasim et al., 2018). The body mass index is a simple index that commonly used to classify underweight, overweight and obese in adults. It is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2) (Gupta and Kapoor, 2014). A person with a BMI of 25 or more is considered by WHO to be overweight, while obesity is defined as having a BMI of 30 or more (WHO, 2018). There prevalence is continuously increasing among people in many countries, irrespective of age or gender. An estimated 1.9 billion adults worldwide, approximately 40% of the adult population, are overweight, with 650 million (13%), of those also classified as obese (WHO, 2018), in Gaza Strip is 71% (El Kishawi, Soo, Abed and Muda, 2014; Husseini et al., 2009), while in Egypt, Bahrain, Jordan, Kuwait, Saudi Arabia and United Arab Emirates ranges from 74% to 86% in women (WHO, 2018). Women are more likely to be overweight and obese than male that has significant effects on reproductive health and specifically pregnancy, in obese females an increased risk of gestational diabetes, preeclampsia, operative delivery, fetal macrosomia, and neonatal morbidity (Mitchell and Shaw, 2015). The main role of the pituitary hormone thyrotropin (TSH) is to regulate the function of thyroid gland. The serum level of TSH is a reliable index of the biological activity of thyroid hormones (THs) (Å;svold, Bjøro and Vatten, 2009). THs is an important modulator of lipid metabolism and metabolic rate, facilitating lipolysis and increasing the use of fatty acids as fuels, resulting in reduced fat accumulation and body weight (Friedman, 2009). In Gaza Strip, there are few published reports focused on hormonal changes associated with obesity in adult females. In

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this case-control study, we aimed to assess the relationship between obesity and body mass index, thyroid stimulating hormone (TSH), total triiodothyronine (T3), total thyroxine (T4), glucose, complete blood count (CBC), calcium, protein, kidney, liver and lipid profile levels among Palestinian adult females.

2. Materials and methods

2.1. Study population and experimental design

This study used case-control design. The population of the study includes 188 individuals based on evaluation of obesity among adult females aged (18–50) years old in Gaza Strip. Cases comprised 94 obese female with BMI > 30 kg/m^2 and equal number non-obese women with BMI 18.5–24.9 kg/m^2 apparently healthy individuals as a control group. The study conducted in private nutritional center and the main general hospitals in Gaza Strip during period from May 2015 to November 2016. Exclusion criteria apparently not healthy or pregnant female. For ethical consideration, the necessary approval to conduct this study was obtained from Helsinki committee for ethical approval number PHRC/HC/30/15 in the Gaza Strip and all study participants signed an informed consent form.

2.2. Specimen collection and processing

Blood samples were collected in alavender top tube (EDTA and serum) and tested within 2 h of collection. Serum were separated by centrifugation for 10 min at 2500 rpm, the separated samples were frozen at −20 °C. Sample were allowed to reach room temperature (20–30 °C) before performing the assay.

2.3. Hematological analysis

A complete system of reagents (control or calibrator) for a Cell Dyne 1800 electronic counter (Sequoia-Turner Corporation, California, USA) was used to perform complete blood count (CBC).

2.3.1. Biochemical analysis

Serum glucose, TC and TG were determined by enzymatic colorimetric method (Barham and Trinder, 1972; Fossati and Prencipe, 1982; Richmond, 1973). Liquid HDL-C precipitant for the determination of HDL-C (Grove, 1979). Total protein and albumin were determined by photometric test according to biuret and bromocresol green method, respectively (Thomas, 1998). Serum urea and uric acid were determined by colorimetric method, while creatinine by using kinetic test without deproteinization (Newman and Price, 1999). Aspartate aminotransferase and alanine aminotransferase activities were measured by using optimized ultraviolet-test according to international federation of clinical chemistry and laboratory medicine (Thomas, 1998). Serum Ca^{2+} was measured using Electrolyte analyzer. TSH, T_3 and T_4 concentration were determined using enzyme-linked immunosorbent assay (ELISA) (Hopton and Harrop, 1986).

2.4. 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.

3. Results

3.1. Socio-demographic and anthropometric measurements

Table 1 shows the socio-demographic characteristics of the study population with no significant differences between obese and non-obese control group according to the Chi-square tests. The age of study population ranged from 20 to 50 years with mean of 30.12 ± 9.3 years for obese female and 33.26 ± 7.8 years for non-obese control group. As indicated in (Table 2), BMI in obese female was significantly higher compared to control group (37.2 ± 4.7 vs 23.4 ± 1.0, % change = 59.2, $P \leq 0.001$).

3.2. Physiological and biochemical parameters

The hematological parameters of obese female compared to apparently healthy non-obese female were illustrated in (Table 3). The mean levels of hemoglobin (Hb – 12.1 ± 1.5 g/dL vs. 13.0 ± 1.2 g/dL), hematocrit (Hct – 35.7 ± 3.8% vs. 39.1 ± 3.7%), mean corpuscular volume (MCV– 80.5 ± 7.8 fl vs. 83.9 ± 3.9 fl), mean corpuscular hemoglobin (MCH – 16.9 ± 0.53 vs. 19.5 ± 0.3 pg) and red cell distribution width (RDW – 14.0 ± 1.9% vs. 12.6 ± 1.3% were significantly lower among obese female compared to non-obese control group ($P \leq 0.001$). Platelet and red cell distribution width were significantly increased in obese compared to non-obese control group (287.4 ± 72.7, 14.0 ± 1.9 vs 265.5 ± 64.3, and 12.6 ± 1.3 respectively, $P \leq 0.05$). On the other hand, no significant differences were found in red blood cell, white blood cell and mean corpuscular hemoglobin concentration among obese female compared to control. Statistically significant increase in the mean of cholesterol (89.4 ± 42.3, vs 170.4 ± 16.6 mg/dl, $P \leq 0.001$), triglyceride (156.6 ± 63.5, vs 138.7 ± 23.6 mg/dl, $P \leq 0.01$) and LDL-C (117.7 ± 35.0, vs 102.5 ± 17.6 mg/dl, $P \leq 0.001$) in obese female compared to control, with percentage change (10.0, 15.2 and 13.3, respectively). No statistically significant differences on glucose, total protein, albumin, globulin, urea, creatinine, uric acid, AST, ALT and free calcium between the two groups were found (Tables 4, 5). TSH was significantly decreased in obese female compared to non-obese control group (2.16 ± 1.23 vs 3.23 ± 1.18 μIU/ml, % change = -32.9, $P \leq 0.001$). Triiodothyronine hormone (T_3 – 1.31 ± 0.40 vs 1.20 ± 0.29 ng/ml, $P < 0.05$) and thyroxin hormone (T_4 – 8.83 ± 1.83 vs 8.31 ± 1.49 μg/dl, $P < 0.05$) were significantly increased in obese female compared to control group (Table 5).

Significant correlations between body mass index and studied parameters were illustrated in (Table 6). There was a negative correlation between body mass index with thyroid stimulating hormone (r = −0·323, $P \leq 0·001$), and a positive correlation with triiodothyronine (r = 0.124, $P \leq 0·05$), and thyroxin hormone (r = 0.120, P ≤ 0·05). A positive correlation between body mass index with total cholesterol (r = 0.318, $P \leq 0·01$), triglyceride (r = 0.178, $P \leq 0·01$), low-density lipoprotein (r = 0.270, $P \leq 0·001$), red cell distribution width (r = 0.354, $P \leq 0·001$) and platelets (r = 0.202, P ≤ 0·01). There was a negative correlation between body mass index with hemoglobin (r = −0.359, $P \leq 0·001$), hematocrit (r = −0.377, $P \leq 0·001$), mean corpuscular volume (r = −0.258, $P \leq 0·001$) and mean corpuscular hemoglobin (r = −0.313, $P \leq 0·001$).

4. Discussion

Obesity is the fifth leading cause of death, globally reaching unprecedented levels. The impact of obesity on the development of coronary artery disease appears to be greater in female than male (Wilson PW, D'Agostino RB, Sullivan L, Parise H, & WB, 2002). Raised BMI is a great public health concern, as it is associated with a number of non-communicable diseases and morbidity, including diabetes, cancer and heart disease (Krauss RM, Winston M, Fletcher BJ, & SM., 1998). Thyroid hormones and some metabolic parameters may vary in obese and non-obese females. We aimed to evaluate the associations between thyroid hormones, metabolic parameters and obesity, and attempt to elucidate the correlation between BMI and various parameters among Palestinian adult females.

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)[a]		(30.12 ± 9.3)[a]			
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		

The significant of difference was checked by one-way ANOVA test (compare all vs. control), significant at $P \le 0.05$.
[a] Values are expressed as means ± standard deviation (SD) of 94 individuals.

Table 2
Anthropometric measurements of the study population.

Anthropometric measurement	Non-Obese female	Obese female	% Change	t-value	*P*-value
Weight (kg)	73.1 ± 5.2	87.7 ± 12.8	19.9	10.223	0.001
(min-max)	63–83	61.3–117.8			
Height (m)	1.56 ± 0.07	1.53 ± 0.08	−1.7	−2.323	0.021
(min-max)	1.36–1.68	1.41–1.73			
BMI (min-max)	23.4 ± 1.0	37.2 ± 4.7	59.2	27.7	0.001
	20.1–24.9	30.2–52.4			

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 ≥ 30.0 were classified obese.
Values are expressed as means ± standard deviation (SD) of 94 individuals.
The significant of difference was checked by one-way ANOVA test (compare all vs. control), significant at $P \le 0.05$.

Table 3
Hematological parameters of the different study groups.

Parameters	Non-Obese female	Obese female	% Change	t-value	*P*-value
RBCs ($\times 10^6$/μL)	4.41 ± 0.41	4.38 ± 0.43	−0.6	−0.429	0.669
(min-max)	2.4–5.4	2.9–5.4			
WBC ($\times 10^3$/μL)	6.79 ± 1.99	7.22 ± 1.79	6.3	1.559	0.121
(min –max)	3.5–15.98	3.5–11.81			
PLT ($\times 10^3$/μL)	265.5 ± 64.3	287.4 ± 72.7	8.2	2.18	0.030
(min –max)	115–414	170–556			
Hb (g/dl)	13.0 ± 1.2	12.1 ± 1.5	−7.8	−5.212	0.001
(min-max)	7.2–14.9	7.7–15.1			
Hct (%)	39.1 ± 3.7	35.7 ± 3.8	−8.5	−6.072	0.001
(min-max)	22.6–44.7	25.9–44.7			
MCV (fl)	83.9 ± 3.9	80.5 ± 7.8	−4.0	−3.737	0.001
(min-max)	70.5–94	58.2–98.2			
MCH (pg)	19.5 ± 0.3	16.9 ± 0.53	−6.1	−4.169	0.001
(min-max)	22.3–31.9	18.3–31.8			
MCHC (g/dl)	33.8 ± 1.4	33.5 ± 2.3	−0.9	−1.168	0.244
(min-max)	29–36.8	28–39			
RDW (%)	12.6 ± 1.3	14.0 ± 1.9	11.3	5.908	0.001
(min-max)	10.4–18.3	10.4–21.2			

RBC; Red blood cell, WBC; White blood cell, PLT; Platelet, Hb; hemoglobin, Hct; Hematocrit, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin; MCHC; mean corpuscular hemoglobin concentration; red cell distribution width.
Values are expressed as means ± standard deviation (SD) of 94 individuals.
The significant of difference was checked by one-way ANOVA test (compare all vs. control), significant at $P \le 0.05$.

BMI was significantly higher in obese female compared to non-obese control group. This finding was in agreement with (Kitahara et al., 2012). obesity are defined as abnormal or excessive fat accumulation that may impair health and the presence of a BMI ≥30 (Bhaskaran et al., 2014; WHO, 2018). BMI is the metric measure for defining anthropometric height/weight characteristics in adults and for categorizing them into groups (Nuttall, 2015). 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 (Chaput et al., 2010).

Our study demonstrates that hemoglobin, hematocrit, mean corpuscular volume and mean corpuscular hemoglobin were significantly decreased in obese females. A positive correlation between body mass index with red cell distribution width and platelets and negative

Table 4
Glucose, lipid and protein profile of the study population.

Parameters	Non-Obese female	Obese female	% Change	t-value	*P*-value
Cholesterol (mg/dl)	170.4 ± 16.6	189.4 ± 42.3	10.0	4.053	0.001
(min-max)	139–245	107–453			
Triglycerides (mg/dl)	138.7 ± 23.6	156.6 ± 63.5	15.2	2.554	0.011
(min-max)	66–234	48–508			
LDL-C (mg/dl)	102.5 ± 17.6	117.7 ± 35.0	13.3	3.773	0.001
(min-max)	66–155	52–303			
HDL-C (mg/dl)	41.2 ± 4.4	40.3 ± 4.8	−2.4	−1.371	0.172
(min-max)	33–52	32–54			
Glucose (mg/dl)	90.0 ± 9.9	93.5 ± 21.73	3.8	1.419	0.158
(min-max)	79–130	67–195			
Total protein (gm/dl)	7.14 ± 0.27	7.17 ± 0.27	0.5	0.855	0.394
(min-max)	6.2–7.6	6.2–7.8			
Albumin (gm/dl)	4.18 ± 0.26	4.19 ± 0.27	0.4	0.410	0.682
(min-max)	3.5–5	3.7–4.8			
Globulin (gm/dl)	2.95 ± 0.27	2.97 ± 0.27	0.6	0.503	0.615
(min-max)	2.1–3.77	2.3–3.57			

LDL-C; low-density lipoprotein and HDL-C; high-density lipoprotein.
Values are expressed as means ± standard deviation (SD) of 94 individuals.
The significant of difference was checked by one-way ANOVA test (compare all vs. control), significant at $P \leq 0.05$.

correlation with hemoglobin, hematocrit, mean corpuscular volume and mean corpuscular hemoglobin. Our findings are in agreement with (Jafarzadeh et al., 2010). The association between increase in BMI and decrease in hemoglobin level may be due to the increase of inflammatory activity in the adipose tissue of obese individuals, which would lead to a higher production of hepcidin, a key hormone for the regulation of intestinal absorption and iron homeostasis (Ganz and Nemeth, 2006). Platelets count in obese females was significantly higher than in non-obese. This finding is consistent with (Kutluturk et al., 2009). There is an ongoing debate on whether obesity is accompanied with platelet activation. Higher concentrations of adipose tissue originating inflammatory markers may contribute to atherogenesis and thrombosis through its effects on platelets activation (Samocha-Bonet et al., 2008).

Our results showed that the mean levels of cholesterol, triglyceride and low-density lipoprotein-cholesterol were significantly increased in cases compared to control. Also positive correlation between body mass index with total cholesterol, triglyceride, and low-density lipoprotein. These results were in consistent with (Mwafy et al., 2018; Nagila et al., 2008). The higher concentrations of serum lipids in cases is mainly due to insulin resistance that developed in obese individuals. Resistance to

Table 6
The correlation of BMI with study parameters.

Parameters	BMI (Kg/m^2)	
	Pearson correlation (r)	*P*-value
TSH	−0.323	0.001
T_3	0.124	0.046
T_4	0.120	0.050
TC	0.318	0.001
TG	0.178	0.007
LDL-C	0.270	0.001
Hb	−0.359	0.001
Hct	−0.377	0.001
MCV	−0.258	0.001
MCH	−0.313	0.001
RDW	0.354	0.001
PLT	0.202	0.003

TSH; Thyroid stimulating hormone, T_3; Triiodothyronine hormone, T_4; Thyroxin hormone, TC; total cholesterol, TG; triglyceride, LDL-C; low-density lipoprotein, PLT; Platelet, Hb; hemoglobin, Hct; Hematocrit, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin and RDW; red cell distribution width. $P > 0.05$: not significant, $P < 0.05$: significant.

Table 5
Kidney, Liver function, Free Ca^{2+}, TSH and thyroid hormones levels parameter of the study population.

Parameters	Non-Obese female	Obese female	% Change	t-value	*P*-value
Urea (mg/dl)	32.0 ± 6.5	31.7 ± 6.2	−1.0	−0.345	0.731
(min-max)	17–57	19–55			
Creatinine (mg/dl)	0.8 ± 0.1	0.8 ± 0.1	−2.7	−1.122	0.263
(min-max)	0.6–1.36	0.5–1.4			
Uric Acid (mg/dl)	4.6 ± 0.9	4.7 ± 1.0	1.4	0.434	0.665
(min-max)	2.7–8.6	2.5–8.8			
AST (U/L)	25.4 ± 13.8	25.4 ± 13.9	−0.02	−0.003	0.997
(min-max)	8.2–130.4	7.6–131			
ALT (U/L)	21.4 ± 13.3	21.3 ± 13.4	−0.39	−0.044	0.965
(min-max)	6–100	4–102			
Free Ca^{2+} (mg/dl)	4.45 ± 0.43	4.34 ± 0.65	−2.3	−1.302	0.194
(min-max)	1.1–5.2	1.02–4.9			
TSH (μIU/ml)	3.23 ± 1.18	2.16 ± 1.23	−32.9	−6.067	0.001
(min-max)	1.1–6.2	0.2–6.8			
T_3 (ng/ml)	1.20 ± 0.29	1.31 ± 0.40	9.5	2.205	0.029
(min-max)	0.4–1.8	0.4–2.8			
T_4 (μg/dl)	8.31 ± 1.49	8.83 ± 1.83	6.3	2.153	0.033
(min-max)	4.1–11	4.1–13.4			

AST; Aspartate Transaminase and ALT; Alanine Transaminase, TSH; Thyroid stimulating hormone, T_3; Triiodothyronine hormone, T_4 and Thyroxin hormone.
Values are expressed as means ± standard deviation (SD) of 94 individuals.
The significant of difference was checked by one-way ANOVA test (compare all vs. control), significant at $P \leq 0.05$.

the action of insulin on lipoprotein lipase in peripheral tissues may also contribute to the elevated triglyceride and LDL-C levels (Jung and Choi, 2014).

The mean levels of TSH were significantly lower while T_3 and T_4 were significantly higher in cases compared to control. Moreover, revealed a significant negative correlation between body mass index with thyroid stimulating hormone and a positive correlation with triiodothyronine, and thyroxin hormone. These findings were in agreement with other studies (Milionis and Milionis, 2013; Yu et al., 2019). The mechanism that explain the high values of T_3 and T_4 has been related to the fact that the expressions of both TSH and THs are reduced in adipocytes of obese subjects as compared to individuals of normal weight. This would prompt decreased tissue responsiveness to circulating THs and would explain the consequent increased compensatory secretion of TSH and T_3 in an attempt to force the state of peripheral resistance (Nannipieri et al., 2009).

5. Conclusions and recommendations

Obesity was associated with thyroid hormones, metabolic parameters and body mass index in Palestinian adult females. An important finding was the increase mean serum levels of cholesterol, triglyceride, LDL-C, T_3 and T_4 while TSH were decrease with BMI increase. TSH, T_3 and T_4 are very important test and frequent monitoring of lipid profile is necessary for obese females. Health educational programs focusing on risk factors of obesity and its dangerous consequences are highly appreciated. The finding is a clarion call for obese individuals with relatively higher thyroid hormones, metabolic parameters might benefit more from body weight regulation using weight-loss diets.

Declaration of competing interest

The authors declare no conflicts of interest.

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