SUBCLINICAL HYPOTHYROIDISM AMONG OVERWEIGHT AND OBESE EGYPTIAN CHILDREN AND ADOLESCENTS

By

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ABSTRACT

Background: *Childhood obesity is a worldwide health problem and its prevalence is increasing steadily and dramatically all over the world. Obese and overweight children and adolescents have a much greater likelihood than normal-weight children and adolescents of acquiring dyslipidemia, elevated blood pressure, impaired glucose metabolism, and hormonal disturbances which significantly increase their risk of cardiovascular and metabolic diseases. Of the various hormonal disturbances observed in childhood overweight and obesity, subclinical hypothyroidism (SH), defined as serum levels of thyroid-stimulating hormone (TSH) above the upper limit with normal concentrations of free T4 (FT4), is the most common and is often regarded as an adaptive response to reduce body weight by increasing the metabolic rate.*

Objective: *this study was designed to evaluate thyroid function among overweight and obese Egyptian children and adolescents for prevalence of subclinical hypothyroidism.*

Patients and Methods: *This is a cross-sectional study that was conducted on 100 Egyptian children and adolescents aged 2 to 18 years. It was carried out on 40 overweight, 40 obese and 20 normal weight children and adolescents as a control group. They were selected from pediatric endocrinology clinic and outpatient pediatric clinic at Al Hussein University Hospital from January, 1st 2021 to June, 1st 2021. they were selected by simple random method. Each included child was submitted to medical history taking, complete clinical examination and laboratory investigations in the form of CBC, serum TSH, FT4, cholesterol, triglyceride, HDL and LDL.*

Results: *Prevalence of subclinical hypothyroidism is increased in higher BMI groups. 12.5 and 27.5% of overweight and obese had subclinical hypothyroidism respectively. Total cholesterol and triglyceride levels were higher in groups with subclinical hypothyroidism than normal children. Body mass index (BMI) was positively correlated with serum concentrations of the TSH and negatively correlated with serum concentrations of FT4 after adjusting for age. The concentrations of total cholesterol and triglyceride were positively correlated with the TSH concentrations following adjustment for age and BMI standard deviation scores. The FT4 concentrations were*

negatively linked with total cholesterol after adjusting for age and BMI standard deviation scores.

Conclusion: *Subclinical hypothyroidism was common in the obese and overweight groups, and the concentrations of TSH were linked with the lipid profile. Subclinical hypothyroidism in obese and overweight children or adolescents should be closely monitored while also evaluating metabolic risk factors.*

Keywords: *Childhood obesity, Subclinical hypothyroidism, body mass index, thyroid-stimulating hormone, cholesterol.*

INTRODUCTION

Over the past few decades, childhood obesity has emerged as a major public health problem in the developed as well as developing countries (Ng M, et al., 2014). It is associated with several physical, psychological, metabolic, and hormonal disturbances **(Dayal D, et al., 2014)**.

Children with obesity may manifest metabolic problems such as dyslipidemia, hypertension, impaired glucose tolerance, insulin resistance (IR), hypoferremia, polycystic ovarian syndrome, and non-alcoholic steatohepatitis which contribute to the risk of cardiovascular diseases and diabetes in later life **(Siyaram D, et al., 2018)**.

These metabolic problems are attributed to the excess of adipose tissue, which works as an endocrine organ. The hormonal problems due to obesity result in changes in the plasma concentrations, secretory patterns and clearance of various hormones **(Fontenelle LC, et al., 2016)**.

Of the various hormonal disturbances observed in childhood obesity, thyroid dysfunction in the form of subclinical hypothyroidism (SH) is the most common **(Fontenelle LC, et al., 2016)**.

Subclinical hypothyroidism (SH), also known as isolated hyperthyrotropinemia, mild hypothyroidism or biochemically compensated primary hypothyroidism, is a biochemical condition characterized by serum TSH concentrations above the upper limit of the reference range, but normal concentrations of free T4 (FT4) and T3 **(Salerno, et al., 2020)**.

The average prevalence of thyroid dysfunction in children and adolescents with overweight and obesity is about 14% (range, 9.2–22.2%) **(Dahl M, et al., 2017)**.

Thyroid hormones regulate the basal metabolism through playing

a role in lipid and glucose metabolism **(Damiano F, et al., 2017)**. Thyroid dysfunction leads to changes in body weight and composition **(Santini F, et al., 2014)**. As a result, the association between obesity and thyroid dysfunction has drawn attention **(Kara O, 2020)**.

The underlying mechanism of thyroid hormone alterations in the obese is not clear **(Pacifico L, et al., 2012)**. However, various mechanisms including iodine deficiency, autoimmune thyroid disease, TSH receptor gene mutation, thyroid hormone resistance, increased leptin levels, leptin-mediated production of pro-TSH-releasing hormone, impaired feedback due to a lowered number of T3 receptors in the hypothalamus and decrease in peripheral deiodinase activity have been proposed **(Ghergherehchi R and Hazhir N, 2015)**.

Besides, a positive correlation was found between the body mass index (BMI) and the TSH level in various studies conducted with obese and overweight children and adolescents **(Unüvar T, et al., 2014)**.

Furthermore, the TSH levels are observed to increase with increasing weight **(Knudsen N, et al., 2005)**. All these changes in the obese are considered to be an adaptation for increasing the resting energy expenditure **(Reinehr T, 2010)**.

Subclinical hypothyroidism (SH) usually reverses after weight loss and does not require any specific treatment **(Fontenelle LC, et al., 2016)**.

However, patients are often initiated on levothyroxine (LT4) due to a widely prevalent belief among clinicians that LT4 treatment along with other obesity interventions results in normalization of body weight **(Fontenelle LC, et al., 2016)**.

The European Thyroid Association and several pediatric thyroid societies recommend that the decision to initiate LT4 treatment in children with TSH 5-10 mU/L and normal T4 concentrations should be taken on an individual basis **(Dayal D, et al., 2015)**.

AIM OF THE WORK

To evaluate thyroid function among overweight and obese Egyptian children and adolescents for prevalence of subclinical hypothyroidism.

ETHICAL CONSIDERATION:

1. A written informed consent was obtained from parents or the legal guardians before the study.

2. An approval by the local ethical committee was obtained before the study.
3. The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.
4. All the data of the patients and results of the study are confidential & the patients have the right to keep it.
5. The patient has the right to withdraw from the study at any time.

Financial Disclosure/ Funding:

The authors received no financial support for the research, authorship and/ or publications of this article.

PATIENTS AND MATERIALS

This cross-sectional study was conducted on 100 Egyptian children and adolescents aged 2 to 18 years. It was carried out on 40 overweight, 40 obese and 20 normal weight children and adolescents as a control group. All the studied children and adolescents were selected from pediatric endocrinology clinic and outpatient pediatric clinic at Al Hussein University Hospital from January, 1st 2021 to June, 1st 2021 by simple random method.

Inclusion criteria:

1. An age of 2-18 years of both sexes,
2. No symptoms of overt hypothyroidism,
3. Presence of normal free T4 (0. 8-1.8 ng/dL) after lab. investigation,
4. TSH between 5 and <10 m IU/L after lab. investigation,
5. No organic or syndromic obesity.

Exclusion criteria:

1. Children on levothyroxine therapy at the time of assessment,
2. Use of ay medications that may interfere with thyroid function test as antithyroid medications, corticosteroids, and thiazides,
3. Underweight,
4. Presence of symptoms of overt hypothyroidism.

Methodology:

All cases and controls were subjected to the following:

1. **Full history taking including:**
   - Age and sex.
   - Stress on absence of symptoms of overt hypothyroidism.
   - Dietary history.

- Family history of obesity, diabetes or hypertension.
- Life style (Organized sports practicing, TV and media watching, sleep and special habits).

2. **Full clinical examination:** general (including vital signs and anthropometric measurements; weight, height, body mass index (BMI), BMI standard deviation score (SDS), waist circumference, hip circumference and waist hip ratio) and systemic (chest, heart, abdomen and neurological examination).

3. **Investigations:**

For each patient the following investigations were done:

1. Complete blood count (CBC); done by automated hematology analyzer.
2. TSH; done by radioimmunoassay.
3. Free T4; done by radioimmunoassay.
4. Lipid profile (serum cholesterol, triglyceride, HDL and LDL); done by colorimetric kits.

Children's weight will be measured lightly dressed and without shoes while Height will be measured to the nearest 0.1cm.

Up to Date calculators based on Egyptian growth charts were used for measurement of body mass index (BMI), body mass index standard deviation score (BMI SDS), BMI percentile and BMI Z-score;

1. Patients below 5^{th} percentile (<−1.65 BMI Z-score) were categorized as underweight, excluded.
2. Patients between 5^{th} and 85^{th} percentile (−1.65 − +1.04 BMI Z-score) as healthy weight, (control group).
3. Patients between 85^{th} and 95^{th} (+1.04 − +1.65 BMI Z-score) as overweight.
4. Patients above 95th percentile (>+1.65 BMI Z-score) as obese.

Children with TSH < 5 m IU/l were considered normal while those with TSH levels between 5 and <10 m IU/L will be considered asymptomatic hypothyroidism.

All participants with high TSH levels will be considered for a second re-measurement. For these participants, second TSH levels will be considered for the study. Participants with TSH levels equal or above 5 mIU/L and lower than 10 mIU/L with normal free T4 levels were categorized as subclinical hypothyroid children

based on the 2014 European Thyroid Association guideline on management of subclinical hypothyroidism in children.

TSH levels above 10 mIU/L are considered overt hypothyroidism and as a result will be not included in this study.

Our patient will be divided into the following groups:

1. Obese children with sub clinical hypothyroidism,
2. Obese children with normal thyroid function,
3. Overweight children with sub clinical hypothyroidism,
4. Overweight with normal thyroid function,
5. Normal weight children (control).

Statistical analysis:

Data were statistically described in terms of mean ± standard deviation (± SD), or frequencies (number of cases) and percentages when appropriate.

Comparisons were performed by using ANOVA for continuous variables, Comparison of numerical variables between the study groups was done using Student t test for independent samples Mann-Whitney U test.

For comparing categorical data, Chi square ($\chi 2$) test was performed. Exact test was used instead when the expected frequency is P value of <0.05.

Correlation between various variables was done using Pearson moment correlation equation and Multiple linear regressions were used to develop an association between thyroid hormone concentrations and variables such as lipid profile with or without adjustment for age and BMI.

A P value of <0.05 was considered statistically significant.

All statistical calculations were done using computer programs SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 25 for Microsoft Windows.

RESULTS

This cross-sectional study was conducted on 100 Egyptian children and adolescents from both sexes and aged 2 to 18 years. It was carried out on 40 overweight (28 males and 12 females), 40 obese (22 males and 18 females) and 20 normal weight (12 males and 8 females) children and adolescents as control group. They were selected from pediatric endocrinology clinic and outpatient pediatric clinic at Al Hussein University Hospital, during the period from January, 1st 2021 to June, 1st 2021 by simple random method.

The results will be shown in the following tables and figures:

Table (1): Correlation between Demographic characteristics and thyroid status among the studied groups:

Demographic characteristic	Study groups										Test	
	Overweight(n=40)				Obese(n=40)				Control (n=20)		X^2	pvalue
	SH	%	E	%	SH	%	E	%	N	%		
Gender: Male	3	7.5	25	40.3	7	17.5	15	37.5	12	19.3	44.3	0.78
Female	2	5	10	25	4	10	14	35	8	21.2		
Age (years) Mean ± SD	13.4 ± 1.98				13.4 ± 1.98				14.4±2.36		25.3	0.56

*p<0.05 is statistically significant,X2 Chi square test
SH: subclinical hypothyroidism, E: euthyroid, N: number

Table (1) shows that there is no statistically significant difference between the studied patients as regard age and sex. Also, the prevalence of subclinical hypothyroidism is increased in higher BMI groups.

Table (2): correlation between Anthropometric measures and thyroid status among the studied groups

Anthropometric measures	Study groups					Test	
	Overweight (n=40)		Obese (n=40)		Control (n=20)	*t-test*	*p* –value
	SH	E	SH	E			
Weight (kg) Mean ± SD	46.54 ± 15.83	44.54 ± 15.83	58.72 ± 19.90	57.72 ± 19.90	30.54 ± 13.00	2.50	**0.010***
Height (cm) Mean ± SD	142.44 ± 16.40	141.5 ± 15.40	142.72 ±15.01	142.72 ±15.1	131.08 ± 20.63	-1.964	**0.863**
BMI (kg/m^2) Mean ± SD	22.12 ± 2.91	20.12 ± 2.8	27.49 ± 5.21	25.49 ± 5.21	16.84 ± 2.47	8.983	**<0.001****
SDS BMI Mean ± SD	2.36 ± 0.18	2.25 ± 0.15	2.95± 0.39	2.89± 0.35	2.55± 0.78	-5.724	**<0.001****
Waist circumference (cm) Mean ± SD	78.8 ± 5.8	77.82± 5.8	89.4 ±10.9	87.5±9. 9	67.9± 7.0	8.335	**<0.001****
Hip circumference (cm) Mean ± SD	97.25± 11.15	96.09±1 1.15	99.09±1 1.15	98.09±1 1.15	97.09±10 .15	7.045	**<0.001****
Waist/hip ratio Mean ± SD	**5.5 ±0.6**	**5.4 ±0.6**	**6.8± 0.6**	**6.5± 0.6**	**99.09± 0.3**	**4.547**	**<0.001****

*p<0.05 is statistically significant, **$p \leq 0.001$ is highly significant
SH: subclinical hypothyroidism, E: euthyroid, N: number

Table (2) shows Values are presented as a number (%) or mean ± standard deviation.

Weight, Height, BMI body mass index, body mass index; SDS, standard deviation score; thyroid hormone; uses the Chi-square test independent sampling test. The Mann-Whitney U Test.

There is statistically significant difference between the studied groups regarding weight, body mass index, waist circumference, hip circumference and waist to hip ratio. There is non-significant difference between them regarding height.

Table (3): correlation between Lipid profile and thyroid profile among the studied groups:

Variable	Study groups					Test	
	Overweight(n=40)		Obese(n=40)		Control (n=20)	*t*	*pvalue*
	SH	E	SH	E			
Serum triglycerides (mg/dl) Mean ± SD	**42.536 ±27.455**	**69.604 ±25.135**	**47.563 ±22.815**	**47.176 ±19.335**	**35.189± 19.335**	4.049	**<0.001****
Total cholesterol (mg/dl) Mean ± SD	**163.183 ± 27.455**	**158.93 ±25.135**	**168.21 ±0.63**	**167.05 ±23.201**	**158.156 ±25.522**	2.478	**0.017***
HDL cholesterol (mg/dl) Mean ± SD	**50.27 ±16.241**	**51.043 ±15.468**	**45.243 ± 9.667**	**44.469 ±9.281**	**52.977 ±9.667**	-3.439	**0.95**
LDL cholesterol (mg/dl) Mean ± SD	**106.34 ±25.522**	**105.953 ±25.135**	**108.66 ±24.748**	**108.273 ±23.975**	**93.579 ±23.201**	3.463	**0.001****
TSH (µIu/ml) Mean ± SD	4.97 ±1.77	3.11 ±1.65	6.45 ±2.13	3.11 ±2.	3.05 ±1.85	-3.759	**<0.001****
Free T4 (ng/dl) Mean ± SD	**1.39 ±0.27**	**1.11 ±0.15**	**1.39 ±0.26**	**1.39 ±0.26**	**1.43 ±0.25**	**-1.382**	**0.173**

*p<0.05 is statistically significant, ** $p \leq 0.001$ is statistically highly significant
SH: subclinical hypothyroidism, E: euthyroid, N: number

Table (3) shows that there is statistically significant increase between the studied groups regarding serum triglycerides, LDL cholesterol and TSH.

While there is no statistically significant difference between the studied groups regarding FT4.

Table (4): Correlation between TSH and demographic, anthropometric measures and lipid profile among the studied patients

Demographic, anthropometric measures and lipid profile	TSH
	p- value
Age	0.088
Weight (kg)	0.039*
Height (cm)	0.112
BMI (kg/m^2)	<0.001**
Waist circumference (cm)	0.01*
Hip circumference (cm)	0.019*
Waist/hip ratio	0.027*
Serum triglycerides	0.02*
Serum total cholesterol	0.044*
HDL cholesterol	0.219
LDL cholesterol	0.056*

*p<0.05 is statistically significant, **p≤0.001 is statistically significant, r Spearman correlation coefficient

There is significant positive correlation between serum TSH in the studied patients and all of body weight, BMI, waist and hip circumference and waist to hip ratio while there is non-significant negative correlation between serum TSH and both age and height of the studied patients.

There is significant positive correlation between serum TSH in the studied patients and serum triglycerides, total cholesterol and LDL cholesterol while there is non-significant negative correlation between serum TSH and HDL cholesterol.

Table (5): Correlation between free T4 and demographic, anthropometric measures and lipid profile among the studied patients

Demographic, anthropometric measures and lipid profile	Free T4 (p value)
Age	0.151
Weight (kg)	0.112
Height (cm)	0.115
Waist circumference (cm)	0.598
Hip circumference (cm)	0.661
Waist/hip ratio	0.111
Serum triglycerides	0.119
Serum total cholesterol	0.219
HDL cholesterol	0.125

*p<0.05 is statistically significant, **p≤0.001 is statistically significant, r Pearso correlation coefficient

There is significant negative correlation between free T4 of the studied patients as regard age, anthropometric measures and lipid profile among the studied patients.

Table (6): Correlation between TSH and free T4 among the studied patients

Variables	TSH	
	r	**p**
Free T4	-0.064	0.695

r Spearman correlation coefficient

There is non-significant negative correlation between serum TSH and free T4 among the studied patients.

Table (7): Correlation between TSH and free T4 among the studied groups

Variables	BMI	
	r	**p**
TSH	0.549	<0.001**
Free T4	-0.103	0.475

r Spearman correlation coefficient

There is significant positive correlation between serum TSH and BMI among the studied patients.

There is non-significant negative correlation between BMI and free T4 among the studied patients.

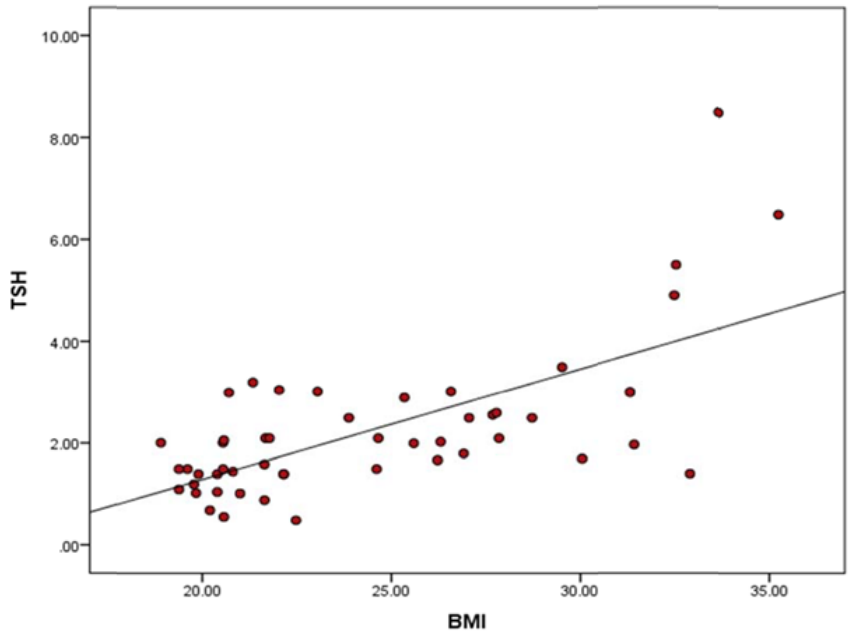

Figure (1): Show correlation between BMI, TS

Figure (1) Scatter dot graph showing significant positive correlation between TSH, and BMI among the studied groups.

Table (8): Multivariate regression analysis of factors associated with obesity among the studied patients

Variables	Odds ratio	95% confidence interval		p
		Lower	Upper	
Age (years)	0.615	0.389	0.971	0.037*
TSH (µIu/ml)	34.489	1.224	972.076	0.038*
Total cholesterol (mg/dl)	1.174	1.003	1.375	0.046*
HDL cholesterol (mg/dl)	0.538	0.295	0.981	0.043*

*p<0.05 is statistically significant

Table (8) shows Increasing age and HDL-cholesterol levels was a significant protective factor against obesity among the studied patients (OR=0.615and 0.538 for age and HDL cholesterol respectively, p<0.05). Increasing serum TSH level and total cholesterol (though among normal range) significantly increases risk of obesity by 34.5 and 1.17 folds respectively.

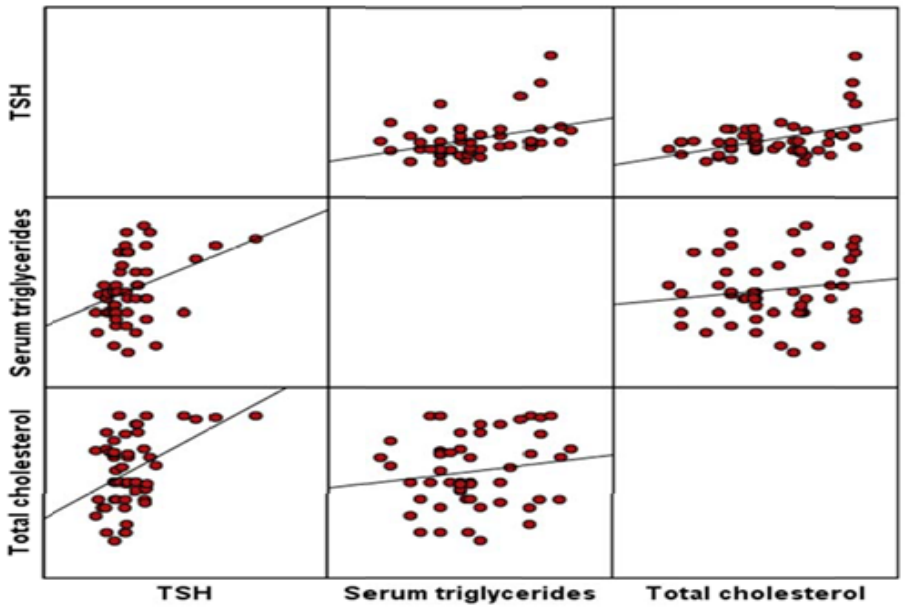

Figure (2): Show correlation between BMI, TSH

Figure (2) Scatter dot graph showing significant positive correlation between TSH, and BMI among the studied groups.

DISCUSSION

Obesity is a common childhood disease and is widely acknowledged as having become a global epidemic during childhood and adulthood, affecting health and psychological welfare. During the past three decades, there has been a considerable increase in prevalence of obesity in both developed and developing countries. Therefore, obesity is currently identified as a major health problem **(Galloway et al., 2010)**.

Hence, it is important to prevent and control hyperlipidemia and thyroid dysfunction in obese children. Considering the high prevalence of these diseases among obese children and its association with cardiovascular complications, our work aimed to evaluate thyroid function (TSH and FT4) in the context of lipid profile in children and Adolescents with simple obesity. This study was done on 100 Egyptian children and adolescents at aged 2-18 years; 40 obese, 40 overweight and 20 normal weight children and adolescents as control group.

As regards age, our study revealed no statistically significant difference in the studied group (p=0.421) **Table (1)**.

As regards gender, our study showed no significant difference between the studied groups (P= 0.325) **Table (1)**. This agrees with **Cynthia et al. (2012)** who showed the same results in their study.

But, **Wisniewski and Chernausek (2009)** revealed that gender differences were common, both before and during puberty. Boys are more prevalent for development of obesity more than girls because of difference in body composition, patterns of weight gain, hormone biology, and the susceptibility to certain social, ethnic, genetic, and environmental factors.

In contrast, a study done by **Reddy et al. (2009)** reported that young females were heavier than young males, and among black teenagers these differences were attributed to over eating in females compared with under eating in males. A national survey among South African school children showed that the prevalence of overweight in black female students was 20.9% compared to 4.2% in males. It can therefore be seen that within all age groups in South Africa there are gender and ethnicity related differences in the prevalence of obesity. These differences are probably a result of cultural, socio-economic and genetic factors which also underlie the worldwide obesity epidemic.

As regards anthropometric measures, there is statistically significant difference between the studied groups regarding weight (t= 2.50, P= 0.010), body mass index (t= 8.983, P < 0.001), waist circumference (t = 8.335, p < 0.001), hip circumference (t= 7.045, P< 0.001) and waist to hip ratio (t= 4.547, P< 0.001). There is non- significant difference between them regarding height (t= -1.964, P = 0.001). as shown in **(Table 2)**.

As regards lipid profile, our study revealed that there is statistically significant difference between the studied groups regarding serum triglycerides (t= 4.049, P < 0.001), total cholesterol (t= 2.478, P = 0.017), HDL cholesterol (t= -3.439, P = 0.001) and LDL cholesterol (t= 3.463, P = 0.001) **(Table 3)**.

Plourde (2002) studied Impact of obesity on glucose and lipid profiles in adolescents at different age groups in relation to adulthood from 1974 to 2000. This retrospective-prospective longitudinal study confirmed that adolescents aged between 13 and 15 years old of both sexes with a BMI ≥ 85th percentile are at increased risk of becoming overweight or obese adults and presenting abnormal glucose and lipid profiles as adults. This emphasizes the importance of

early detection and intervention directed at treatment of obesity to avert the long-term consequences of obesity on the development of cardiovascular diseases.

Zimmet et al. (2007) showed that obese children had significantly higher values of abdominal obesity and high cholesterol which are considered dangerous risk factors for cardiovascular disease and type II diabetes in comparison with non-obese children.

Lima et al. (2004) stated that the lipid profile of the overweight and obesity groups showed borderline or undesirable values, especially in male patients, total and LDL-cholesterol levels were higher than those found by **Severina et al. (2004)** which may be attributed to the high intake of saturated fat and to the low intake of dietary fiber.

As regards thyroid profile, there is statistically significant difference between the studied groups regarding TSH (z/t= -3.759, P < 0.001), as shown in **(Table 3)**.

Serum TSH concentration positively associates with BMI (p-value=0.985, P < 0.001) **(Table 4)** and this was in agreement with **(Aeberli et al., 2010**; **Grandone et al., 2010** and **Marras et al., 2010)**. **Wolters et al. (2013)** showed that thyroid function abnormalities observed in obese patients usually normalize after weight reduction, suggesting that thyroid dysregulation reflects an adaptive process to weight excess. The relationship of TSH level to anthropometric parameters describing abdominal obesity, confirmed in the present study, might indirectly suggest an association between leptin and increased TSH.

Ruminska et al. (2016) evaluated thyroid function in the context of glucose and lipid metabolism in children with simple obesity. This retrospective study encompassed 110 obese children and 38 healthy non-obese children aged 5–18. The obese children demonstrated significantly higher mean concentrations of TSH compared with their peers with proper body weight. The mean levels of TSH increased with increasing BMI. The mean concentration of FT4 did not differ between the obese and non-obese groups. In all patients, serum FT4 level was within the reference range. The TSH value did not correlate with fT4 and this was in agreement with our study as shown in **(Table 6)**.

In our study, there is significant positive correlation between serum TSH of the studied patients

and body weight (r=077, P = 0.039), BMI (r= 0.874, P < 0.001), waist circumference (r= 932, P = 0.01) and hip circumference (r= 0.963, P = 0.019), waist to hip ratio (r= 0.963, P = 0.027), serum triglycerides (r= 0.89, P = 0.02), total cholesterol (r= 0.78, P = 0.044). There is non-significant correlation between serum TSH and age (r= -0.124, P = 0.088), height (r= -0.089, P = 0.112), HDL cholesterol (r= 0.065, P = 0.219), LDL cholesterol and free T4 (r= 985, P =0.695) **(Table 4, 6)**.

In our study, it was noted that the mean T4 concentration was higher in control group compared with obese group as shown in **Table (3)**.

Marras et al. (2010) reported that there is an inverse correlation between free thyroxine (fT4) values and body mass index (BMI), even when FT4 values remain in the normal range. Lately, it has also been suggested that abnormalities in thyroid function may be secondary to weight excess. These changes, however, would still be functional, as suggested by their normalization after weight loss.

Our results come in contradiction to the **Reinehr and Andler, (2002)** who studied 118 obese children and 107 healthy children of normal weight from children attending the intervention program (Obeldicks) for obese children between 1999 and 2000. They found that T3 and T4 were significantly higher in obese children compared to those of normal weight, **Reinehr et al., (2006)** who studied 246 obese and 71 normal weight children, found that no significant difference in FT4 levels between obese and normal weight children. However, these studies failed to explain how TSH is elevated in presence of high T3 and T4 or even normal levels and its negative pituitary feedback.

Ruminska et al. (2016) found that serum TSH values correlated with age, BMI, WHR, and WHtR. The association between TSH and BMI demonstrated a borderline significance. There was a trend for the association between TSH and the percentage of lean body mass (% LEAN) in obese children, but not the percentage of fat mass as estimated with bioelectrical impedance analysis. Total cholesterol, LDL cholesterol, triglycerides and non-HDL correlated with TSH, even after controlling for BMI.

Ruminska et al. (2016) found that in the multivariate regression analysis with TSH, as a dependent variable, and the independent variables describing weight status

(BMI, SDS BMI, WC, WHR, WHtR, and % FAT) after controlling for age and gender, TSH significantly correlated with BMI and WC.

As **vold et al. (2013)** demonstrated a relationship between adverse changes in the lipid profile and increasing TSH concentration, even when it remains within the normal range; as having been found in a 11-year follow-up.

In a prospective study in 206 obese children, **Aeberli et al. (2010)** have shown a relationship between TSH, but not fT4 or fT3, and total cholesterol (TC), low–density lipoprotein cholesterol (LDL- C) and triglycerides (TG). During a 2-month weight loss intervention, changes in TSH were good predictors of the corresponding changes in high-density lipoprotein cholesterol (HDL-C).

Likewise, **Pacifico et al. (2012)** have shown that elevated TSH is a predictor of lipid and glucose disorders, and also hepatic steatosis.

Ruminska et al. (2016) found a significant association of TSH with TC, LDL-C, TG, and non-HDL, but not with HDL cholesterol. They concluded that the serum TSH concentration, even remaining within the norm, could adversely affect the lipid profile, irrespective of obesity.

LIMITATION OF THE STUDY

According to these results, we must take in consideration that the main limitations of this study include:

- Small number of the sample, therefore, future researches with larger sample size are needed.
- The most important limitation of this study is that while it illustrates a positive link between serum TSH levels and BMI Z-score, it does not reveal the causality of this link. Is obesity causing higher levels of serum TSH, or is progression of subclinical hypothyroidism causing weight gain?
- Another limitation is that while anti thyroid peroxidase (Anti-TPO) Ab levels are not required for a subclinical hypothyroidism diagnosis, they are recommended for considering therapeutic treatment of the disease and they would have certainly helped in a better analysis of the subjects in this study.

CONCLUSION

- Prevalence of subclinical hypothyroidism is higher in overweight and obese children and increase in BMI Z score

and serum TSH levels are closely linked.

- Based on results of this study, a thyroid profile test should be considered in approach to obesity and overweight in children. If subclinical hypothyroidism is found in obese children, a weight loss plan may lead to a decrease in serum TSH levels and a drug therapy may not be needed.
- Thyroid dysfunction has an impact on lipid profiles.
- The concentrations of total cholesterol and triglyceride were positively associated with thyroid-stimulating hormone (TSH) concentrations in children and adolescents.

RECOMMENDATION

- Checkup thyroid function and lipid profile in all overweight and obese children and adolescents.
- Measures should be done to reduce weight and control of obesity.
- Overweight and obese children with subclinical hypothyroidism should start thyroxin therapy.

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دراسة قصور الغدة الدرقية تحت الإكلينيكي بين الأطفال والمراهقين المصريين الذين يعانون من زيادة الوزن والسمنه

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الهدف من البحث: تهدف هذه الدراسة لتقييم وظيفة الغدة الدرقية بين الأطفال والمراهقين المصريين الذين يعانون من زيادة الوزن والسمنة من أجل انتشار قصور الغدة الدرقية تحت الإكلينيكي.

الوسائل والادوات: أجريت هذه الدراسه كدراسة مقطع عرضي على 100 طفل ومراهق مصري من سن 2-18 عام والذين يعانون من زيادة الوزن والسمنه خلال الفتره من الاول من يناير الى الاول من يونيو لسنة 2021 خلال ترددهم على العيادة الخارجيه لقسم الاطفال والعيادة الخارجيه لوحدة الغدد الصماء بقسم الاطفال بمستشفى الحسين الجامعي بالقاهره. وتم اختيارهم بطريقة عشوائية بسيطة، حيث تم إخضاعهم جميعا لأخذ التاريخ الطبي كاملا، والفحص السريري الشامل، وعمل الفحوصات المخبرية اللازمه.

نتائج البحث: وجد ان هناك زياده في انتشار قصور الغدة الدرقية تحت الإكلينيكي في مجموعات مؤشر كتلة الجسم الأعلى. حيث وجد ان 12.5 و 27.5٪ من الاطفال الذين يعانون من زيادة الوزن والسمنة يعانون من قصور الغدة الدرقية تحت الإكلينيكي على التوالي. كانت مستويات الكوليسترول الكلي والدهون الثلاثية أعلى في المجموعات المصابة بقصور الغدة الدرقية تحت

الإكلينيكي. ارتبط مؤشر كتلة الجسم بشكل إيجابي مع تركيزات هرمون المحفز للغده الدرقيه وربط سلبًا بتركيزات هرمون الثيروكسين الحر، بعد التعديل حسب العمر. ارتبطت تركيزات الكوليسترول الكلي والدهون الثلاثية بشكل إيجابي مع تركيزات هرمون المحفز للغده الدرقيه بعد التعديل حسب العمر ودرجات الانحراف المعياري لمؤشر كتلة الجسم. ارتبطت تركيزات هرمون الثيروكسين الحر سلبًا مع الكوليسترول الكلي بعد تعديل درجات الانحراف المعياري للعمر ومؤشر كتلة الجسم.

الاستنتاج: كان قصور الغدة الدرقية تحت الإكلينيكي شائعًا في مجموعات السمنة والوزن الزائد، وكان يوجد ارتباط وثيق بين تركيزات هرمون المحفز للغده الدرقيه ومستوى الدهون. يجب مراقبة قصور الغدة الدرقية دون الإكلينيكي عند الأطفال أو المراهقين الذين يعانون من السمنة المفرطة وزيادة الوزن عن كثب أثناء تقييم عوامل الخطر الأيضية.