The relationship between T3, T4, TSH, and Vitamin D3 in obese women from a small population in Basrah City

Eman H. Rahi [1], Zahraa Mahmoud Hussain Al-Hejaj [2]*, Duha T. Al-Taie [3], Zainab Alaa Abdulateef Almusawi [4]

[1], [2], [4] Department of Fundamental Science, College of Nursing, University of Basrah, Basrah, Iraq.

[3] Directorate of Education Maysan, Ministry of Education, Iraq.

* Corresponding author: zahraa.hussain@uobasrah.edu.iq

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ABSTRACT

Background: Obesity is a state characterized by excessive deposition of fat. Thyroid hormones are known to influence body weight, and thyroid diseases, which are linked to vitamin D deficiency as risk factors. **Material and methods:** A total of 35 samples aged from 25 – 50 years were collected during the period from November 2022 to January 2023. The subjects were divided into two major groups depending on their BMI. The anthropometric measurements including height, body weight, waist and hip circumferences, were measured for all participants. **Results:** the results showed that there was a significant decrease in the level of T3 in obese women compared with lean women (p=0.042), On the other hand, no significant differences were observed in T4, TSH, and D levels between the two groups. Furthermore, there was a positive correlation between vitamin D and T3 in the obese group (r= 0.587, p= 0.046) and there was no correlation between vitamin D and other hormones (T4, TSH).

Conclusion: Vitamin D was decreased in the study population regardless the weight moreover, there was a decrease in the level of T3 in obese women compared to thin women, furthermore, the study showed a slight increase in TSH concentration in the two groups and simple decrease of T4 level in obese women but it is still with normal range. These conclusions may be an indicator of subclinical hypothyroidism.

Keywords: Obesity, Subclinical hypothyroidism, Vitamin D, Thyroid hormones.

INTRODUCTION

Obesity is a condition described by abnormal accumulation of adipose fat, and it commonly results in the development of various related disorders. Globally, the prevalence of obesity is rising and is now considered an epidemic by the World Health Organization (1,2). Thyroid hormones are recognized to regulate basic metabolism and thermogenesis, as well as lipid and glucose metabolism, food intake, and lipid oxidation. Thus, it influences on body composition (3,4). Strong associations are found between obesity, weight maintenance, and thyroid hormones, and many mechanisms appear to be involved in it (5).

Vitamin D, a steroid hormone, is important in bone mineral homeostasis, growth, and maintenance of skeletal health. Diabetes mellitus, malignancies, multiple sclerosis, atherosclerosis, infectious diseases, and various autoimmune disorders, including thyroid autoimmune diseases, have all been linked to vitamin D deficiency as risk factors (6-8). This vitamin exerts its biological effects through nuclear vitamin D receptors (VDR) which are present in most human cells and tissues. Therefore, vitamin D functions by controlling the gene expression in several locations where its receptors are present, such as the endocrine system (9-11).

Due to the comparable response elements on genes, thyroid hormones, and vitamin D both function through steroid receptors and they may influence one another's actions. Therefore, a reduced vitamin D level is likely to make the systemic problems linked to hypothyroidism worse (6,12,13). This research aims to study the possible relationship between vitamin D, thyroid hormones, and body mass index in obese women.

MATERIALS AND METHODS

1. Study population

A total of 35 samples aged 25 – 50 years were collected from the staff of the College of Nursing at Basrah University during the period from November 2022 to January 2023. Before collecting samples, a brief review of the study was given to the participants. Before being included, all individuals provided written informed consent. Through direct interviews and the use of a questionnaire, the medical histories of the women and some data were collected.

2. Study design

Based on their BMI, the patients were divided into two major groups. Ten lean women with BMIs between 18 and 24.9 made up Group I (the control), and 25 healthy obese women with BMIs above 30 made up Group II. The exclusion criteria include having any chronic disorders, endocrine disease, being treated with medication, being pregnant, and having irregular menstrual cycles.

3. Anthropometric measurements

Measurements of the anthropometric parameters, such as height, weight, and hip and waist circumferences, were taken.

4. Serum preparation

About 2 ml of venous blood was collected and placed in a serum separation tube. To induce clot formation, wait for around 10 minutes. Then, the samples were placed in a centrifuge at 3500 rpm for 10 minutes at room temperature to get the serum. The serum was stored in deep freeze at (-20°). The serum was measured by enzymatic colorimetric assay, using COBAS INTEGRA 400 plus.

5. Statical analysis

The data was analyzed by SPSS program version 26 (independent t-test) and significant differences were determined at p-value <0.05.

RESULTS

Table (1) showed that there was a significant decrease in the level of T3 in obese women than in lean women (p=0.042), On the other hand, despite the study results showing the presence of a simple decrease or increase of T4, TSH and D level between obese and control subjects, statistically, there were no significant differences was observed in T4, TSH and D levels between the two groups (p= 0.333, p= 0.59, p= 0.543) respectively.

Table 1: independent two sample T-test (obese and normal Sample) Compared to T3, T4, TSH hormone and vitamin D							
Variables	Sample	N	Mean	Sd	Significant		
					T – value	P – value	Sig.
T3 (nmol/l)	Obese	25	1.20	0.175	2.607*	0.042	S
	Lean	10	1.48	0.392			
T4 (μu/l)	Obese	25	129.68	13.107	0.982	0.333	Ns
	Lean	10	135.10	18.429			
TSH (μu/l)	Obese	25	9.84	4.031	1.959	0.59	Ns
	Lean	10	7.15	2.488			
Vitamin D (nmol/l)	Obese	25	15.56	3.606	0.627	0.543	Ns
	Lean	10	16.80	5.806			

*S= Significant at p= < 0.05, Ns = no significant

Table (2) showed that there was a positive correlation between vitamin D and T3 in the obese group (r= 0.587, p= 0.046) and there was no correlation between vitamin D and other hormones (T4, TSH).

Table 3: Pearson's Correlations for obese sample (n = 25)					
		T3(nmol/l)	T4 (μu/l)	TSH (μu/l)	D (nmol/l)
T3 (nmol/l)	Pearson Correlation	-	0.309	0.258	0.587*
	P – value	-	0.133	0.213	0.046
T4 (μu/l)	Pearson Correlation	-		0.021-	0.118
	P – value	-	-	0.921	0.574
TSH (μu/l)	Pearson Correlation	-	-	-	0.116
	P – value	-	-	-	0.580
D (nmol/l)	Pearson Correlation	-	-	-	-
	P – value	-	-	-	-

*S= Significant at p = < 0.05

DISCUSSION

Vitamin D is a fat-soluble secosteroid synthesis by the skin through exposure to UV light, and orally from natural foods, fortified meals, and supplements. Although the skin is the main source of vitamin D production, oral consumption takes precedence over sun exposure in the treatment and prevention of nutritional vitamin D deficiency (14, 15).

The status of vitamin D in people is influenced by a variety of biological and environmental variables working together. These factors include variations in sunlight exposure caused by latitude, seasons, time of day, atmospheric components, clothes, sunscreen application, and color of skin. In addition to age, obesity, and the presence of various chronic diseases (16-18).

Vitamin D deficiency is known as serum 25(OH)D values under 20 ng/mL, and vitamin D insufficiency as serum 25(OH)D ranges between 20 and 30 ng/mL, while the optimal level of 25(OH)D values between 30 and 50 ng/mL (19, 20).

The results of this study showed a decrease in vitamin D concentration in both groups, since statistically no significant differences in these levels between obese and lean women. These results agreed with a previous study that the level of vitamin D is not only lower in an obese group but also lower in lean persons (21, 22). The reason for this result may be due to the type of lifestyle, for example, the main barrier that prevents vitamin D production and its normal levels is clothing. This could be explained by the fact that women in southern Iraq typically cover practically all their bodies with clothing and show only a little area of skin for social and religious reasons. Furthermore, the weather conditions in Basrah city characterized by high temperatures and the long period of summer make people avoid going out during the day as much as possible (23, 24).

This suggestion was demonstrated in a previous study which found that women who dress in a more Western manner have greater levels of vitamin D than women who wear the hijab. Vitamin D cannot be synthesized in sufficient amounts when the hands and face are exposed to the sun while wearing a headscarf (25, 26).

In contrast, in a different study, the researchers showed that vitamin D insufficiency was more common in obese individuals than control group (27, 28). Moreover, an investigation revealed that BMI and vitamin D levels correlated negatively. This association is most likely caused by heavier people engaging in less physical activity and getting less sun exposure (29-31). These differences in study findings could be ascribed to the sample size of the study, the age range of the participants, the assay-use techniques, and other variables that interact with each other.

Moreover, the results of the study showed that there was a significant decrease in the level of T3 in obese women compared to thin women. This was inconsistent with Tagliaferri, since, decreased fT4 with a slight increase in T3 or free T3 (fT3) levels have been shown in obese subjects (32).

Furthermore, the results of this study showed a simple increase of TSH concentration in the two groups and a simple decrease in T4 level in obese women (statically not clear) but it is still within the normal range. These results are consistent with the status known as subclinical hypothyroidism, which is defined as an increase of thyroid-stimulating hormone level or TSH level with normal concentration of free thyroxine (FT4) (33).

A cross-sectional study in the north Indian population of Meerut revealed similar results, in the vitamin D deficiency group higher TSH levels and normal levels of T4 inclined towards a lower reference range were found (6). Elevated TSH levels with normal serum thyroxine (T4) levels were also found in obese children and adolescents, and it may be considered as signs of subclinical hypothyroidism (32). Another cross-sectional study was conducted from 2014 to 2016 on participants with obesity, free t4 was lower in people with obesity but there was no significant difference in TSH level between the two groups (35, 36).

In contrast, in a previously published study performed, no subclinical hypothyroidism was observed in obese participants, since the obese group had higher TSH levels, although those concentrations were still in the normal reference range (21).

The differences in the study design, the definitions of the normal range for TSH and T4, the degree of obesity, the status of iodine, smoking, and some other factors that are currently unknown may be possible reasons for the variation in the results (37).

Moreover, the findings of this study showed a significant positive correlation between vitamin D and T3 ($r= 0.587$, $p = 0.046$), and no correlation between vitamin D and TSH or T4 ($r=0.116$, $p=0.580$; $r=0.118$, $p=0.574$) respectively. These results agreed with a previous study in India since vitamin D deficiency showed a significant positive correlation with T3 and T4. In contrast, a significant negative correlation was found between vitamin D and TSH (6). This association could be explained by how vitamin D affects the production of type 2 deiodinase, which leads to the peripheral conversion of T4 to T3 (38).

CONCLUSION

Vitamin D was decreased in the study population regardless of the weight of participants, moreover, there was a decrease in the level of T3 in obese women compared to thin women, furthermore, the study showed a slight increase in TSH concentration in the two group, and simple decrease of T4 level in obese women but it is still with normal range. These conclusions may be an indicator of subclinical hypothyroidism.

RECOMMENDATION

Conducting more extensive studies on vitamin D and thyroid hormones especially in people with thyroid disorders in both genders and various ages.

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REFERENCES

1. Martins T, Castro-Ribeiro C, Lemos S, Ferreira T, Nascimento-Gonçalves E, Rosa E, et al. Murine models of obesity. Obesities. 2022;2(2):127-47.
2. Tiryag AM, Atiyah HH. Nurses' knowledge toward obesity in al-Basra city. Annals of the Romanian Society for Cell Biology. 2021:4667-73.
3. Christoffersen BØ, Sanchez-Delgado G, John LM, Ryan DH, Raun K, Ravussin E. Beyond appetite regulation: Targeting energy expenditure, fat oxidation, and lean mass preservation for sustainable weight loss. Obesity. 2022;30(4):841-57.
4. Tiryag AM, Atiyah HH. Nurses’ Knowledge toward Bariatric Surgery at Surgical Wards at Teaching Hospitals in Al-Basra City. Indian Journal of Forensic Medicine & Toxicology. 2021;15(3):5152-9.
5. Laurberg P, Knudsen N, Andersen S, Carlé A, Pedersen IB, Karmisholt J. Thyroid function and obesity. European thyroid journal. 2012;1(3):159-67.
6. Koch N, Kaur J, Mittal A, Gupta A, Kaur IP, Agarwal S. Status of vitamin D levels in hypothyroid patients and its associations with TSH, T3 and T4 in north Indian population of Meerut, a cross sectional study. International Journal of Clinical Biochemistry and Research. 2016;3(3):295-8.
7. Rahi EH, Al-Hejaj ZMH, Tiryag AM. Nurses' Knowledge of Nonalcoholic Fatty Liver Disease: A Cross-Sectional Study. Academia Open. 2024;9(1):10.21070/acopen. 9.2024. 10306-10.21070/acopen. 9.2024. 10306.
8. Al-Hejaj ZMH. Bridging the Knowledge Gap on Iron Deficiency Anemia Among Nursing Students. Academia Open. 2024;9(2):10.21070/acopen. 9.2024. 10283-10.21070/acopen. 9.2024. 10283.
9. Ławnicka H, Galant-Gdula A, Motylewska E, Komorowski J, Świętosławski J, Stępień H. Estimation of vitamin D status in patients with secondary and primary hypothyroidism of different etiology. Neuroendocrinology Letters. 2018;38(8).
10. Ashok T, Palyam V, Azam AT, Odeyinka O, Alhashimi R, Thoota S, et al. Relationship between vitamin D and thyroid: an enigma. Cureus. 2022;14(1).
11. Tiryag A, Atiyah M, Khudhair A. Nurses' Knowledge and Attitudes toward Thyroidectomy: A Cross-Sectional Study. Health Education and Health Promotion. 2022;10(3):459-65.
12. Zainel I, Abdul-Ra'aoof H, Tiryag A. Mothers' Knowledge and Attitudes towards her Children with Neonatal Jaundice: A Cross-Sectional Study. Health Education and Health Promotion. 2022;10(3):565-70.

13. Jabbar M, Mohammad M, Tiryag A. CHANGES IN MALE REPRODUCTIVE HORMONES IN PATIENTS WITH COVID-19. Georgian Med News. 2023(342):42-6.
14. McKenna MJ, Kilbane M. Vitamin D deficiency. Endocrinology and Diabetes: A Problem Oriented Approach: Springer; 2022. p. 245-56.
15. Issa AH, Almayah AA. New Virulence Factor of Normal Flora E. Coli. Systematic Reviews in Pharmacy. 2020;11(2).
16. Tsiaras WG, Weinstock MA. Factors influencing vitamin D status. Acta Dermato Venereologica. 2011;91(2):115.
17. Issa AH, Mohammad HF, Abd Al-Abbas MJ. Epidemiological Genetic Study for Novel World Records of Hepatitis B Virus Strains Detected by DNA Sequences in the South of Iraq/Al-Basrah Province. BioNanoScience. 2021;11:454-62.
18. Allami, Z., ALkhalidi, F., Dragh, M. The Correlations of Vitamin D and Zinc Deficiency with Neck Pain, Fatigue, and Tremors of Muscle: A Case Report and Review of Article. *Journal of Medical and Life Science*, 2024; (): 471-479. doi: 10.21608/jmals.2024.390104
19. Szymczak-Pajor I, Miazek K, Selmi A, Balcerczyk A, Śliwińska A. The action of vitamin D in adipose tissue: is there the link between vitamin D deficiency and adipose tissue-related metabolic disorders? International Journal of Molecular Sciences. 2022;23(2):956.
20. Abed RE, Salman AN, Issa AH, Al-Salih M, editors. Evaluation of the level of IL-2 in the HCV patients in the Thi Qar Province Southern Iraq. AIP Conference Proceedings; 2023: AIP Publishing.
21. Zhou P, Cai J, Markowitz M. Absence of a relationship between thyroid hormones and vitamin D levels. Journal of Pediatric Endocrinology and Metabolism. 2016;29(6):703-7.
22. Kaiyrzhanov R, Rad A, Lin S-J, Bertoli-Avella A, Kallemeijn WW, Godwin A, et al. Bi-allelic ACBD6 variants lead to a neurodevelopmental syndrome with progressive and complex movement disorders. Brain. 2024;147(4):1436-56.
23. Abed RE, Salman AN, Issa AH, Al-Salih M, editors. HCV infection epidemiology in Thi Qar Province, Southern Iraq, from 2005 to 2021. AIP Conference Proceedings; 2023: AIP Publishing.
24. Mohammad MA, Al-Timary AY, Tiryag AM. Safety of Tubeless Double Access Percutaneous Nephrolithotomy Compared to Single Access Approach. Bahrain Medical Bulletin. 2023;45(2).
25. Al-Horani H, Abu Dayyih W, Mallah E, Hamad M, Mima M, Awad R, et al. Nationality, gender, age, and body mass index influences on vitamin D concentration among elderly patients and young Iraqi and Jordanian in Jordan. Biochemistry research international. 2016;2016(1):8920503.
26. Mohammad M, Jassim F, Tiryag A. Retrograde Intrarenal Lithotripsy Using Disposable Flexible Ureteroscope. Georgian Med News. 2024(348):44-6.
27. Pereira-Santos M, Costa PdF, Assis Ad, Santos CdS, Santos Dd. Obesity and vitamin D deficiency: a systematic review and meta-analysis. Obesity reviews. 2015;16(4):341-9.
28. Mohammad MA, Jassim FA, Tiryag AM. Single-use flexible ureteroscope for the treatment of renal stone. Revista Latinoamericana de Hipertension. 2023;18(7).
29. Zhang H, Liang L, Xie Z. Low vitamin D status is associated with increased thyrotropin-receptor antibody titer in Graves disease. Endocrine Practice. 2015;21(3):258-63.
30. Tiryag AM, Dawood SB, Jassim SK. Nurses' knowledge and attitudes about enteral feeding complications by nasogastric tube in intensive care units. Rawal Medical Journal. 2023;48(3):689-.

31. Shhaet, A., Mohammed, M. The relationship between Celiac Disease (CD) and obesity: A Review. *Journal of Medical and Life Science*, 2024; 6(2): 196-201. doi: 10.21608/jmals.2024.358399
32. Tagliaferri M, Berselli ME, Calo G, Minocci A, Savia G, Petroni ML, et al. Subclinical hypothyroidism in obese patients: relation to resting energy expenditure, serum leptin, body composition, and lipid profile. Obesity research. 2001;9(3):196-201.
33. Biondi B, Cappola AR, Cooper DS. Subclinical hypothyroidism: a review. Jama. 2019;322(2):153-60.
34. Akcan N, Bundak R. Accuracy of tri-ponderal mass index and body mass index in estimating insulin resistance, hyperlipidemia, impaired liver enzymes or thyroid hormone function and vitamin D levels in children and adolescents. Journal of clinical research in pediatric endocrinology. 2019;11(4):366.
35. Layegh P, Asadi A, Jangjoo A, Layegh P, Nematy M, Salehi M, et al. Comparison of thyroid volume, TSH, free t4 and the prevalence of thyroid nodules in obese and non-obese subjects and correlation of these parameters with insulin resistance status. Caspian journal of internal medicine. 2020;11(3):278.
36. Abdi H, Faam B, Gharibzadeh S, Mehran L, Tohidi M, Azizi F, et al. Determination of age and sex specific TSH and FT4 reference limits in overweight and obese individuals in an iodine-replete region: Tehran Thyroid Study (TTS). Endocrine Research. 2021;46(1):37-43.
37. Mohammad MA, Abdul-Ra'aoof HH, Razzaq Manahi KA, Tiryag AM. Parents' Knowledge and Attitudes toward Testicular Torsion. Bahrain Medical Bulletin. 2024;46(1).
38. Vassalle C, Parlanti A, Pingitore A, Berti S, Iervasi G, Sabatino L. Vitamin D, thyroid hormones and cardiovascular risk: Exploring the components of this novel disease triangle. Frontiers in Physiology. 2021;12:722912.