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Exploring the Impact of the Ketogenic Diet on Thyroid Function

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Abstract

This study aims to highlight the connection between thyroid health and the ketogenic diet. This study included 120 men aged between (25- 55) years, divided into two groups. Group one contains 70 men following a carbohydrate diet, and group two is 50 men who follow a ketogenic diet; both groups analyzed serum (TSH, T4, T3) and HbA1c. The results show a significant (P≤0.05) decrease in thyroid TSH, T3, and T4. Also, the findings of HbA1c show a significant (P≤0.05) decrease in the ketogenic group compared to those who follow a carbohydrate diet. In conclusion, the ketogenic diet is significantly associated with thyroid function tests. and this achieves one of the sustainable development goals of the United Nations in Iraq which is (Good Health).

Keywords | **ketogenic diet, thyroid function, T3, T4, and TSH**

Introduction:

(Rastoldo G, et al.) The thyroid, a small butterfly-shaped gland nestled in the neck, is pivotal in regulating metabolism and energy balance within the human body (1). (Vancamp P et al.) Its influence extends far beyond its size, impacting everything from the body temperature to heart rate and weight management (2) (Yavuz, S. et al.). This occurs because thyroid hormone receptors are widespread, enabling thyroid hormones to engage with and impact nearly all metabolic pathways across various systems throughout an organism's lifespan. The diverse effect of thyroid hormone results from the interplay between the localized availability of T3 and the intricate signalling mechanisms within cells. Under normal physiological circumstances, this confers temporal and tissue specificity to the hormonal signal, even in minor disparities in circulating levels (3). (Nirmalan et al.) As individuals embark on the journey of ketosis, where the body shifts from relying on carbohydrates to predominantly utilizing fat for fuel, questions arise about the potential effects on thyroid hormones (4). (Kalamian, et al) Thyroid hormones stimulate diverse metabolic pathways that enhance Oxygen Consumption and Heat Production by increasing the basal metabolic rate, and thyroid hormones raise body temperature and energy expenditure (5). (Al-Suhaimi, et al) Thyroid hormones enhance glucose absorption, gluconeogenesis, glycogenolysis, and glucose oxidation, elevating blood sugar levels, increasing insulin secretion and thus stimulating carbohydrate metabolism (6). (De Stefano et al.) Thyroid hormones accelerate lipolysis, breaking stored fats into fatty acids and glycerol, thereby increasing free fatty acids in the bloodstream (7). (Basolo, A., et al.) Also, thyroid hormones promote protein synthesis and degradation, affecting muscle mass and turnover (8). (Iacovides, S., et al) The ketogenic diet, characterized by a significant reduction in carbohydrates and an increase in healthy fats, aims to shift the body's primary energy source from glucose to ketones (9). (Iacovides, S., et al) Understanding the nuances of thyroid function in a ketogenic diet is crucial for those actively pursuing this lifestyle and healthcare professionals seeking to guide their patients

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toward optimal health (10). In this article, we highlight the potential effects of ketosis on thyroid hormones. From the mechanisms at play to practical considerations for those who embrace this dietary model, this study aims to shed light on the connection between thyroid health and the ketogenic diet.

Methods:

In a cross-sectional case/control study conducted for the period between (January 8/2023, and October 25/2023), We measured the body mass index (BMI) and thyroid function tests (T3, T4, and TSH) for all study groups according to the presence or absence of carbohydrates in their food. It included 120 adult males with ages ranging from (25- 55 years), who were tested for biochemical parameters associated with thyroid function. The participants were divided into two groups. Group I consists of males who follow a ketogenic diet (n=50) chosen from the Nutrition clinics, relatives, and society. In contrast, Group II consists of males who follow a carbohydrate diet (n=70) randomly selected from the people who attend the clinics for check-ups, relatives, and colleagues. The TSH, T3, and T4 hormone concentrations were measured using ELK ELISA kits with an ELISA reader and washer Bikaman Keouldeir – USA—measurement of whole blood HbA1c Using the COBAS c111 technique.

Inclusion criteria:
Males who follow a ketogenic diet for periods from 2 – 12 months.

Exclusion criteria:
Males with chronic disorders such as diabetes mellitus, hyperlipidemia, hypertension, liver disease, and malignancy, patients taking treatments for thyroid diseases.

Statistical analysis:
All statistical analyses were performed using the SPSS software (SPSS, ver.24). the data are expressed as mean ±standard deviation, and the comparisons between the two groups were carried out using the t-test. P-values ≤0.05 were considered significant.

Results:

The demographic characteristics of participants are shown in Table 1. When the comparison was made, the matching ages of the study's subjects were confirmed by the non-significant results (p = 0.83). The two study groups significantly differed in BMI (p≤ 0.05). The results showed a significant (P≤0.05) decrease in HbA1c in people with the ketogenic group (5.06 ±0.37) as compared to the group of people who follow a carbohydrate diet (4.3 ±0.46).

Table .1 General characteristics of study subjects

parameter	groups	No.	Mean ± SD	p-value
Age (years)	Males who follow a carbohydrate diet	70	37.47±8.63	0.83 (n.s)
	Males following ketogenic diet	50	36.56±9.04	
BMI(Kg/m^2)	Males who follow a carbohydrate diet	70	29.71 ± 1.59	0.000 (s)
	Males following ketogenic diet	50	24.08 ± 1.02	
HbA1c(%)	Males who follow a carbohydrate diet	70	5.06 ± 0.37	0.000 (s)
	Males following ketogenic diet	50	4.3 ± 0.46	

BMI: Body Mass Index, SD: Standard Deviation, and HbA1c: Glycated haemoglobin A1c

The comparison of biochemical variables among study groups is shown in Table 2. The findings of Serum TSH, T3, and T4 hormonal levels in Males following the ketogenic diet showed a significant

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(P≤0.05) decrease in TSH levels (1.78 ±0.93) as compared to a group of people who followed a carbohydrate diet (2.37 ±0.98); also a significant (P≤0.05) decrease was seen in a group of people who followed a ketogenic diet of both T4 (6.95 ± 1.42) and T3 levels (0.84 ±0.3) in comparison to the group of people who follow a carbohydrate diet.

Table .2 Thyroid Hormone Levels in Ketogenic Diet expressed as Mean ±Standard

p-value	Mean ± SD	No.	groups	Parameters
0.001 (s)	2.37 ± 0.98	70	Males who follow a carbohydrate diet	S.TSH (uIU/ml)
	1.78 ± 0.93	50	Males following a ketogenic diet	
0.000 (s)	1.33 ± 0.71	70	Males who follow a carbohydrate diet	$S.T_3$ (ng/ml)
	0.84 ± 0.3	50	Males following ketogenic diet	
0.000 (s)	8.46 ± 1.85	70	Males who follow a carbohydrate diet	$S.T_4$ (ng/ml)
	6.95 ± 1.42	50	Males following ketogenic diet	

S.TSH: serum thyroid stimulating hormone, $S.T_4$: thyroxine hormone, $S.T_3$:triiodothyronine hormone, SD: Standard Deviation

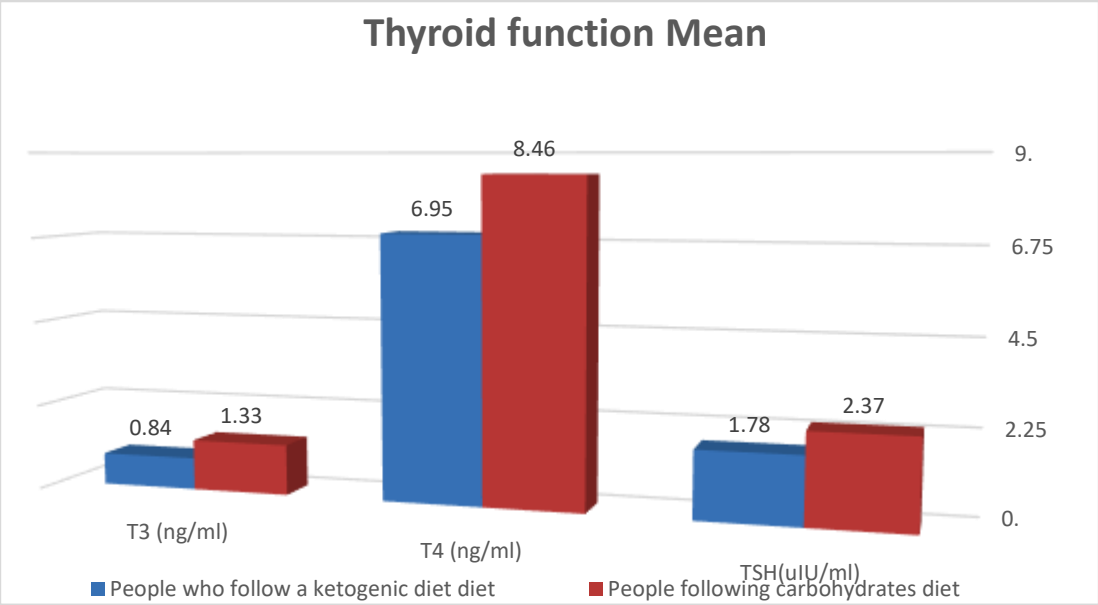

Figure 1: Differences in the means of (TSH, T3, and T4) according to the type of diet of the study population, People who follow a carbohydrate diet and People following a ketogenic diet.

Discussion:

Age was meticulously balanced across the studied groups to minimize its influence, thereby directing attention to changes in the levels of the examined neurotransmitters. The body mass index was also selected to ensure a significant difference between people who depend on a carbohydrate diet and males who follow a ketogenic diet. (Zhang, W., et al) Ketogenic diets often lead to rapid initial weight loss, primarily

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due to the depletion of glycogen stores and associated water loss. This can significantly reduce BMI, particularly in individuals with higher initial BMI values (11). (Ashtary-Larky, D. et al.) Studies have shown that ketogenic diets can effectively reduce body fat, particularly visceral fat, which is associated with an increased risk of metabolic diseases such as type 2 diabetes and cardiovascular disorders. As fat mass decreases, BMI may decrease accordingly (12). (Paoli, A., et al.) The ketogenic diet has been associated with significant weight loss and improvements in various metabolic markers, including HbA1c levels. Excess body weight and adiposity significantly contribute to insulin resistance and impaired glucose metabolism. By promoting weight loss and reducing fat mass, the ketogenic diet may indirectly lead to improvements in HbA1c levels (13). (Zhu, H., et al.)The influence of a ketogenic diet on thyroid function is a subject that merits thoughtful consideration, as the interplay between dietary patterns and hormonal regulation is complex and multifaceted (14). (Partsalaki, Rial-Pensado, E., Giammanco, M.) Numerous studies have explored the potential impact of a ketogenic diet on thyroid hormones, including thyroxine (T4) and triiodothyronine (T3), which play pivotal roles in metabolic rate and overall physiological homeostasis (15), (16), (17). (Walczak, K., Bouazza, A., Bouazza, A., et al)) Some research suggests that the ketogenic diet may alter thyroid hormone levels. Specifically, studies have reported reductions in T3 levels, potentially indicative of a downregulation of thyroid activity. However, these changes clinical significance and long-term implications remain areas of active investigation (18) (19). (Cooper, I. D., et al.) One proposed mechanism behind the observed effects on thyroid function involves the impact of nutritional ketosis on the hypothalamus-pituitary-thyroid (HPT) axis. The decrease in insulin levels and the shift in metabolic substrate utilization during a ketogenic state could influence the HPT axis, leading to changes in thyroid hormone production and release (20). (Kowalik, M. A.,et al) Additionally, ketone bodies' role in modulating thyroid function requires further exploration (21). Also, potential Mechanisms of Ketogenic diets severely restrict carbohydrate consumption, which can decrease insulin levels. Insulin plays a role in promoting the conversion of T4 to T3 so that lower insulin levels may lead to reduced T3 production (10). (Dowis, K. et al.) It is crucial to note that the evidence on the relationship between a ketogenic diet and thyroid function is inconsistent, with some studies indicating minimal or no significant changes in thyroid hormones (22). (Koerich, A. C. C., et al) Factors such as the duration of adherence to the ketogenic diet, individual variations, and the specific composition of the Diet may contribute to the variability in study outcomes (23). Furthermore, the potential impact of a ketogenic diet on thyroid function raises important considerations for individuals with pre-existing thyroid conditions or those considering long-term adherence to this dietary approach (9:269440). (Landry, M. J., et al.) Healthcare practitioners should be attentive to monitoring thyroid hormone levels in individuals following a ketogenic diet, especially those at risk of thyroid dysfunction (24)

Conclusion:

The ketogenic diet affects thyroid hormone levels, and this relationship involves many factors, such as reduced carbohydrate intake, changes in energy balance, and individual variability in metabolic responses. It's essential to consider individual differences in response to the ketogenic diet. In contrast, some individuals may experience alterations in thyroid hormone levels on a ketogenic diet, while others may not exhibit significant changes. Also, ketogenic diets can effectively reduce body fat, particularly visceral fat, which is associated with an increased risk of metabolic diseases such as type 2 diabetes and cardiovascular disorders.

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Recommendations:

Regular Monitoring for individuals following a ketogenic diet, especially those with pre-existing thyroid conditions or concerns, should consider regular monitoring of thyroid function tests. This can help detect potential alterations in thyroid hormone levels and ensure timely intervention if necessary.

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معرفة تأثير النظام الغذائي الكيتوني على وظيفة الغدة الدرقية

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مستخلص البحث

تهدف هذه الدراسة إلى تسليط الضوء على العلاقة بين صحة الغدة الدرقية والنظام الغذائي الكيتوني. شملت هذه الدراسة 120 رجلاً تتراوح أعمارهم بين (25-55) سنة، وتم تقسيمهم إلى مجموعتين. المجموعة الأولى تضم 70 رجلاً يتبعون نظاماً غذائياً يعتمد على الكربوهيدرات، والمجموعة الثانية تضم 50 رجلاً يتبعون نظاماً غذائياً كيتونياً؛ وتم تحليل مصل الدم لكلا المجموعتين **TSH, T4, T3**و **HbA1c.** أظهرت النتائج انخفاضاً كبيراً **P≤0.05** في مستويات **TSH, T3,** و**T4** في الغدة الدرقية. كما أظهرت نتائج **HbA1c** انخفاضاً كبيراً **P≤0.05** في المجموعة الكيتونية مقارنةً بأولئك الذين يتبعون نظاماً غذائياً يعتمد على الكربوهيدرات. وفي الختام، يرتبط النظام الغذائي الكيتوني بشكل كبير بنتائج اختبارات وظائف الغدة الدرقية. وهذا ما يحقق احد اهداف التنمية المستدامة للامم المتحدة في العراق (الصحة الجيدة).

الكلمات المفتاحية | **النظام الغذائي الكيتوني، وظيفة الغدة الدرقية، T3، T4، وTSH**