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Thyroid-Stimulating hormone levels and their association with appetite: A cross-sectional study in an adult population

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ABSTRACT

Appetite regulation involves a complex interaction of physiological, psychological, and hormonal factors. Thyroid-stimulating hormone (TSH), primarily responsible for regulating thyroid function, has recently been associated with appetite control. This study explores the relationship between serum TSH levels and appetite in healthy adults. A cross-sectional study was conducted on 350 adults aged 18-60, recruited from Azadi Teaching Hospital, Duhok, Iraq. Participants with thyroid disorders or metabolic diseases were excluded. Data collection involved a comprehensive questionnaire, face-to-face interviews, and review of medical records. Statistical analysis, including Pearson's correlation, were used to assess associations between serum TSH levels and appetite-related parameters. The study cohort was predominantly female (82.5%) and unemployed (83.4%). TSH levels exhibited a positive correlation with appetite changes (r = 0.1404, p = 0.0085). Creatinine levels showed a moderate positive correlation with age (r = 0.1796, p = 0.0007), while appetite changes did not significantly correlate with age (r = -0.05179, p = 0.9230). This study suggests a potential link between TSH levels and appetite regulation, contributing to a broader understanding of metabolic health. Further research is needed to explore the underlying mechanisms and clinical implications of these findings.

Key words: Appetite regulation, Correlation analysis, Metabolism, Thyroid function, TSH.

1. Introduction

Appetite regulation is a complex interplay of physiological, psychological, and hormonal factors that collectively influence food intake and energy balance in humans (Piaggi et al., 2018; Ashraf and Hassan, 2024). Among the intricate network of hormones involved in appetite control, the thyroid-stimulating hormone (TSH) has gained considerable attention due to its pivotal role in orchestrating metabolic processes. Produced by the anterior pituitary gland, TSH primarily governs thyroid function and the synthesis of thyroid hormones that contribute tometabolic homeostasis (Yoo et al., 2021).

Recent scientific interest has expanded beyond its traditional role to explore potential connections between TSH and appetite regulation (McHill and Wright, 2017; Capuccio et al., 2024).

The intricate relationship between thyroid hormones and metabolism has long been established. Thyroid hormones, triiodothyronine (T3) and thyroxine (T4), regulate basal metabolic rate, body temperature, and energy utilization. Emerging evidence suggests that TSH, conventionally viewed solely as a regulator of thyroid function, might also play a modulatory

role in appetite control (Russo et al., 2021). A growing body of research has begun to unveil potential interactions between TSH and appetite-regulating pathways, posing intriguing questions about their interdependence and potential clinical implications (McAninch and Bianco, 2014). Higher TSH levels, typically indicative of hypothyroidism, are associated with a slower metabolism. This slower metabolic rate can lead to a decreased appetite, as the body's energy requirements are reduced. In contrast, lower TSH levels, characteristic of hyperthyroidism, correspond to a faster metabolism, which often results in an increased appetite due to the body's heightened energy demands (Karimi et al., 2024).

Appetite regulation, on the other hand, encompasses a complex interplay of hormones, neural circuits, and psychological factors that collectively influence hunger, satiety, and food consumption. Hormones such as leptin, ghrelin, and insulin are recognized for their contributions to appetite modulation (Müller et al., 2015). The potential involvement of TSH in this intricate web of regulatory mechanisms raises fascinating possibilities for novel insights into the physiological drivers of appetite and their relevance to overall health. This research paper investigates the relationship between serum TSH levels and appetite in adults, aiming to enhance understanding of hormonal influences on appetite regulation. By exploring potential correlations, the study addresses a gap in the literature and may uncover markers of appetite dysregulation and metabolic disorders. Insights gained could pave the way for future research on the physiological mechanisms underlying appetite control, offering new perspectives on managing appetite-related concerns and promoting healthy metabolic function.

2. Materials and methods

Study design and participants:

This cross-sectional study aimed to investigate the relationship between serum levels and appetite in healthy adults. Ethical approval was obtained from the Research Ethics Committee of the Duhok Directorate General of Health in Duhok, Iraq. All participants provided informed consent before participation. A total of 350 eligible participants were recruited from Azadi Teaching Hospital between June 2023 and August 2023. Inclusion criteria encompassed individuals aged 18 to 60 years, with no history of thyroid disorders, metabolic diseases, or other chronic conditions significantly affecting appetite or thyroid function.

Data collection

Questionnaire

Participants completed a comprehensive questionnaire encompassing various dimensions. The questionnaire captured demographic details such as full name, age, gender, occupation, address, marital status, number of children, income, and education. It also included physical characteristics (weight in kg, height in cm) for calculating the body mass index (BMI). Additional sections covered post-COVID status, vaccination history, smoking habits, alcohol consumption, physical activity level, family history of diabetes, personal history of diabetes, family history of blood pressure, personal history of blood pressure, weight changes, numbness of hands, emotional states (e.g., anger, feeling down), sleep patterns, fatigue, appetite changes, sensitivity to temperature, menstrual cycle details, fast heartbeats, personal history of hypothyroidism or hyperthyroidism, and medication usage (duration, type, and dosage).

Interviews

Trained research personnel conducted face-to-face interviews to ensure accurate data collection. Participants were encouraged to provide additional insights into their appetite experiences, including variations in hunger, preferences for specific food types, and perceptions of fullness.

Medical records review

Baseline demographic information, including age, gender, BMI, and TSH levels, were extracted from participants' medical records. Those with abnormal TSH levels were excluded from the final analysis. Appetite was assessed based on participants' self-reported feelings of hunger, satiety, and changes in food consumption patterns. Although the study did not directly measure biochemical markers such as leptin, ghrelin, or neuropeptides, these subjective measures provide an initial basis for examining associations with TSH levels. Future studies

incorporating direct biochemical assessments are recommended.

Statistical analysis

Collected data were analyzed using GraphPad Prism 9.3.1. Descriptive statistics summarized demographic characteristics, appetite-related parameters, and TSH levels. Correlation analysis, such as Pearson's correlation coefficient, were conducted to assess the association between serum TSH levels and appetite-related variables.

Ethical considerations

The study adhered to the ethical principles outlined in the Declaration of Helsinki. Participant confidentiality and anonymity were maintained throughout the study, and data were de-identified during analysis to ensure privacy.

3. Results

Demographic and health profile analysis of study participants

In this study, various demographic and health-related variables were examined among the study participants (Table 1). Important insights into the characteristics of the population under investigation were revealed. Firstly, a predominance of female participants was observed, comprising 82.5% of the sample, indicating a potential gender disparity in the study cohort. Furthermore, a substantial proportion of participants were found to be unemployed (83.4%) and residing in urban areas (78.2%), suggesting socioeconomic and geographical patterns within the sample. Additionally, diverse backgrounds among participants were reflected in marital status and income distribution, with a majority being married (76.2%) and earning less than $1000 monthly (93.7%). Varied education levels were observed, with a notable representation of individuals holding high school (29.7%) and university degrees (24%). Regarding health-related variables, it was found that the majority of participants did not smoke (92.2%), Participants reported that they do not consume alcohol (99.7%), do not engage in physical activity (83.4%), or do not have a personal history of diabetes (83.7%). Interestingly, no family history of diabetes was reported by 50.8% of participants. Moreover, post-COVID conditions were experienced by 57.1% of participants, while half were pre-vaccinated against COVID-19. These findings underscore the diverse demographic and health profiles of the study population, highlighting the need for targeted interventions and further research to address potential disparities and health outcomes in this context.

Correlation analysis of health and lifestyle factors

Table 2 presents correlation coefficients (r) and corresponding *p*-values for the variables examined in this study. Relationships between various clinical parameters, including thyroid function, appetite changes, creatinine levels, and age within a diverse cohort. Analysis revealed that Thyroid-Stimulating Hormone (TSH) levels exhibited a positive correlation with appetite changes ($r = 0.1404$, $p = 0.0085$), suggesting a potential link between thyroid function and appetite regulation. Additionally, TSH levels displayed a weak positive correlation with creatinine ($r = 0.0257$, $p = 0.6317$), but not significantly with age ($r = 0.04522$, $p = 0.3990$). Creatinine levels, serving as an indicator of renal function, demonstrated a moderate positive correlation with age ($r = 0.1796$, $p = 0.0007$). Interestingly, appetite changes did not show a significant correlation with age ($r = -0.05179$, $p = 0.9230$), indicating a need for further exploration into factors influencing appetite across different age groups. These findings highlight the complexity of interactions between thyroid function, renal function, appetite regulation, and age, offering insights into metabolic health dynamics. Further investigation is essential to elucidate underlying mechanisms and clinical implications of these associations

Table. 1. TSH in relation to demographic and health-related variables among study participants

Variables	General (350)	Less than 0.27 (34)	Normal (179)	More than 4.9 (137)
Gender:				
Female	289 (82.5%)	31 (91.1%)	142 (79.3%)	116 (84.6%)
Male	61 (17.4%)	3 (8.9%)	37 (20.6%)	21 (15.3%)
Occupation:				
Unemployed	292 (83.4%)	27 (79.4%)	144 (80.4%)	121 (88.3%)
Employed	49 (14%)	6 (17.6%)	29 (16.2%)	14 (10.2%)
Retired	9 (2.5%)	1 (2.9%)	6 (0.5%)	2 (1.4%)
Residential areas:				
Urban	274 (78.2%)	27 (79.4%)	128 (71.5%)	119 (86.8%)
Rural	76 (21.7%)	7 (20.5%)	51 (28.4%)	18 (13.1%)
Marital status:				
Single	83 (23.7%)	7 (20.5%)	40 (22.3%)	36 (26.2%)
Married	267 (76.2%)	27 (79.4%)	139 (77.6%)	101 (73.7%)
Monthly Income:				
<1000$	328 (93.7%)	32 (94.1%)	165 (92.1%)	131 (95.6%)
1000-2000$	22 (6.2%)	2 (5.8%)	14 (7.8%)	6 (4.3%)
Education level:				
Primary school	95 (27.1%)	6 (17.6%)	60 (33.5%)	29 (21.1%)
High school	104 (29.7%)	12 (35.2%)	53 (29.6%)	39 (28.4%)
University graduate	84 (24%)	9 (26.4%)	47 (26.2%)	28 (20.4%)
Illiterate	67 (19.1%)	7 (20.5%)	19 (10.6%)	41 (29.9%)
Change a peptide:				
Yes	163 (46.6%)	13 (38.2%)	68 (38%)	82 (60%)
No	187 (53.4)	21 (62.8%)	111 (62%)	55 (40%)
Smoking:				
Yes	27 (7.7%)	1 (97.1%)	17 (9.4%)	9 (6.5%)
No	323 (92.2%)	33 (2.9%)	162 (90.5%)	128 (93.4%)
Alcohol consumption:	1 (0.2%)	0 (0%)	1 (0.5%)	0 (0%)
Yes	349 (99.7%)	34 (100%)	178 (99.5%)	137 (100%)
N				
Physical activity:				
Yes	58 (16.5%)	3 (8.9%)	34 (18.9%)	21 (15.3%)
No	292 (83.4%)	31 (91.1%)	145 (81.1%)	116 (84.6%)
Personal history of diabetes:	57 (16.2%)	2 (5.8%)	30 (9.4%)	25 (18.2%)
Yes	293 (83.7%)	32 (94.1%)	149 (90.5%)	112 (81.7%)
No				
Family history of diabetes:	172 (49.1%)	17 (50%)	87 (48.6%)	68 (49.6%)
Yes	178 (50.8%)	17 (50%)	92 (51.3%)	69 (50.4%)
No				
POST COVID				
Yes	200 ((57.1%)	18 (52.9%)	105 (58.6%)	77 (56.2%)
No	150 (42.8%)	16 (47.1%)	74 (41.3%)	60 (43.7%)
Pre vaccinated				
yes	175 (50%)	16 (47.1%)	95 (53%)	64 (46.7%)
No	175 (50%)	18 (52.9%)	84 (46.9%)	73 (53.2%)

Table 2. Correlation coefficients (r) and *p*-values for examined variables

	TSH		Appetite change		Creatinine		Age	
	r	***p*- value**	**r**	***p*-value**	**r**	***p*- value**	**r**	***p*- value**
Gender	-0.045	0.400	-0.167	0.001	0.357	<0.0001	0.0008	0.987
Post covid	-0.033	0.533	0.057	0.280	0.176	0.0009	0.2007	0.0002
Vaccinated	-0.041	0.438	-0.071	0.181	0.111	0.037	0.1215	0.022
Smoking	-0.052	0.330	-0.080	0.131	0.179	0.0008	-0.029	0.580
Alcohol consumption	-0.038	0.473	-0.054	0.308	0.086	0.107	0.060	0.254
Physical activity	0.012	0.818	-0.100	0.058	0.061	0.251	-0.069	0.196
Family history of diabetes	0.013	0.797	-0.059	0.265	-0.089	0.101	-0.017	0.739
Personal history of diabetes	0.054	0.313	-0.031	0.550	0.138	0.009	0.400	<0.0001
Personal history of blood pressure	0.024	0.654	0.081	0.128	0.115	0.0302	0.452	<0.0001
Family history of blood pressure	0.002	0.968	0.051	0.331	-0.005	0.915	0.029	0.583
Weight gain or lose	0.065	0.219	0.185	0.0005	-0.052	0.326	-0.013	0.798
Numbness of hands	0.039	0.461	0.239	<0.0001	0.023	0.659	0.048	0.369
Angry	0.098	0.065	0.245	<0.0001	-0.051	0.335	-0.067	0.209
Feeling down	0.007	0.891	0.198	0.0002	0.0092	0.862	-0.115	0.030
Trouble sleeping	0.083	0.117	0.315	<0.0001	0.078	0.144	0.165	0.0019
Feeling tired	-0.009	0.853	0.308	<0.0001	0.044	0.410	0.027	0.607
Appetite change	0.140	0.008			-0.038	0.471	-0.005	0.923
Sensitive to temp.	0.042	0.428	0.242	0.0001	0.090	0.091	0.140	0.008
Fast heartbeats	-0.059	0.264	0.186	0.0005	-0.001	0.981	0.033	0.527
Personal history of hypothyroidism or hyperthyroidism	0.023	0.660	0.052	0.327	-0.107	0.044	0.075	0.156
Medication	0.171	0.001	0.080	0.133	0.115	0.030	0.099	0.062
Creatinine	0.025	0.631	-0.038	0.471			0.179	0.0007
TSH			0.140	0.008	0.025	0.631	0.045	0.399
Age	0.045	0.399	-0.051	0.923	0.179	0.0007		
BMI	0.041	0.433	0.002	0.960	0.052	0.330	0.433	<0.0001

r: Correlation coefficient; TSH: Thyroid-stimulating hormone; BMI: Body mass index

4. Discussion

The TSH plays a significant role in appetite regulation (Sanyal and Raychaudhuri, 2016). Elevated TSH levels (hypothyroidism) are often associated with decreased appetite due to reduced metabolic rates (Sanyal and Raychaudhuri, 2016). In the present study, individuals with TSH levels above 4.9 showed a higher tendency to modify appetite-regulating peptides (60% Yes), likely as a response to reduced appetite, consistent with findings by Lin et al. (1983). Conversely, lower TSH levels (hyperthyroidism) were linked to increased appetite, with 62.8% of respondents in this group opting not to change peptides, indicative of their metabolic adjustments. Participants with normal TSH levels demonstrated stable appetite regulation, with 62% preferring no change. These observations underscore the complex interplay between thyroid function and appetite, highlighting the need for tailored management approaches in thyroid disorders. Based on these findings, clinical interventions should aim to monitor and manage TSH levels in patients with appetite dysregulation. For individuals with thyroid dysfunction, personalized strategies targeting appetite-regulating mechanisms may improve metabolic outcomes. Future studies could explore whether modulating TSH levels or addressing specific hormonal pathways, such as ghrelin signaling, could serve as viable therapeutic strategies for managing appetite disturbances in clinical settings. However, further research is necessary to substantiate these approaches before clinical implementation. The demographic and health profile analysis unveiled significant insights into the characteristics of the study

participants. The predominance of female participants in our cohort reflects a potential gender disparity, consistent with findings by Meng et al. (2015). This suggests that thyroid-related health issues may have gender-specific implications requiring further investigation**.** Additionally, the high proportion of unemployed individuals and urban residents reflects socioeconomic and geographic patterns that should be considered in health policy and intervention planning (Unnikrishnan et al., 2013; Nexo et al., 2014). The diversity in marital status, income levels, and educational backgrounds emphasizes the varied socioeconomic contexts of the participants. A majority were married and earned less than $1000 monthly, while many had attained high school or university-level education**.** Health-related behaviors, such as non-smoking, non-alcohol consumption, and absence of diabetes, were prevalent among participants. Additionally, a significant proportion reporting post-COVID conditions highlights the ongoing health impacts of the pandemic. The analysis revealed significant positive correlations between TSH levels and appetite changes, aligning with studies that have reported strong associations between TSH and ghrelin concentrations (Abd El Gawad et al., 2012; Gurgul et al., 2012; Ruchala et al., 2014; Adamczewska et al., 2020). These findings suggest that TSH and ghrelin may jointly influence appetite regulation, presenting a potential area for therapeutic exploration.

In the present study, positive correlation between age and creatinine levels, indicating potential age-related renal function decline, though this contrasts with findings by Yim et al. (2023), who reported an inverse relationship. Furthermore, a strong positive correlation between BMI and age was observed, reinforcing the association between aging and metabolic changes, with implications for age-specific health interventions. The current findings highlighted the intricate relationships among TSH levels, appetite regulation, and various health factors. These results emphasize the need for multi-faceted approaches to health management, considering both metabolic and demographic variables. Future studies should focus on elucidating the underlying mechanisms of these associations and developing targeted interventions for diverse populations. Hypothyroidism, though underdiagnosed, is prevalent in the Arabian Gulf region. Clinical guidelines, such as those proposed by Alzahrani et al. (2020) for Saudi Arabia, provide valuable frameworks for improving diagnosis and treatment. Building on such regional expertise, the present work contribute to the broader understanding of thyroid dysfunction and its systemic impacts.

Limitations of the study

This study has several limitations. The predominantly female and unemployed population may limit the generalizability of the findings. The cross-sectional design prevents establishing causation and excluding individuals with thyroid or metabolic disorders reduces applicability to at-risk groups. Additionally, the weak correlation between TSH levels and appetite changes suggests limited physiological relevance. Future studies with diverse populations and longitudinal designs are recommended to confirm these findings. Future studies should incorporate assessments of stress levels, dietary intake, and additional hormonal markers to better understand their potential role in modulating the relationship between TSH levels and appetite regulation. Although the correlation between TSH levels and appetite changes was statistically significant (p = 0.0085), the correlation coefficient (r = 0.1404) indicates a weak association. This suggests that while there is evidence of a relationship, the effect size is modest, and other factors may contribute more substantially to appetite regulation. Future studies with larger sample sizes and additional variables could help clarify these findings and their physiological relevance.

5. Conclusion

In conclusion, the cross-sectional study revealed a significant positive correlation between serum TSH levels and appetite changes in healthy adults. This suggests a

potential link between thyroid function and appetite regulation. Additionally, age showed a positive correlation with creatinine levels, indicating a possible decline in renal function with increasing age. These findings highlight the intricate interplay between hormonal signaling, appetite regulation, and age, providing valuable insights into metabolic health dynamics. Further research is needed to elucidate underlying mechanisms and inform targeted interventions for improving health outcomes in diverse populations.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Research Ethics Committee of the Duhok Directorate General of Health in Duhok, Iraq, and all participants provided informed consent before participation

Consent for publication

Not applicable

Availability of data and material

All data generated or analyzed during this study are included in this published article

Competing interests

The authors declare that they have no competing interests.

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None.

Authors' contributions

Midya Jalal Ibrahim: Methodology, Data curation. Lina N. Adam: Writing – original draft, Software, Data curation, Supervision, Conceptualization. Sipan Sarbast: Supervision, Conceptualization. Writing – review and editing.

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