

INDUS JOURNAL OF BIOSCIENCE RESEARCH

<https://induspublishers.com/IJBR>

ISSN: 2960-2793/ 2960-2807



Association of Thyroid Hormones with Aggression: A Neuroendocrine Approach

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ARTICLE INFO

Keywords: Thyroid Hormones, Aggression, Neuroendocrinology, Hypothyroidism And Hyperthyroidism, HPA Axis, Emotional Regulation**Correspondence to:** Muhammad Muzammil Masood, Department of Allied Health Professionals, GC University, Faisalabad, Pakistan
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Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.**Conflict of Interest:** No conflict of interest.**Funding:** No funding received by the authors.

Article History

Received: 02-06-2025 Revised: 12-06-2025

Accepted: 22-06-2025 Published: 30-06-2025

ABSTRACT

Aggression, a hybrid behavior with biological, psychological, and social roots, is gradually associated with neuroendocrine mechanisms, particularly thyroid hormones. This review explains the complex association between thyroid hormones and aggressive behavior from clinical, neurodevelopmental, and neuroendocrine perspectives. Thyroid hormones, specifically triiodothyronine (T3) and thyroxine (T4), are critical in brain development, emotion regulation, and neurotransmitter intonation. Dysfunctions like hypothyroidism and hyperthyroidism are often associated with mood disturbances, irritability, impulsive behavior, and aggression. Moreover, the relationship between thyroid hormones and the hypothalamic-pituitary-adrenal (HPA) axis and their action on serotonergic, dopaminergic, and GABAergic systems makes them strong mediators for behavioral outcomes. Sex differences in thyroid dysregulation and aggression also specify the necessity for gender-specific research. Combining together clinical and experimental studies, this review highlights the aptitude of thyroid hormone profiling in risk assessment for aggression to the examination of thyroid-targeted treatments for the management of aggressive psychopathology.

INTRODUCTION

Aggression, a complex social behavior crucial for survival and reproduction, is predisposed by multiple factors together with the neuroendocrine system (Munley et al., 2018). Aggression or anger is a state of mind perceived by nearly everyone in daily routines. But in teenagers, particularly in school life this emotion can be extremely toxic if left uncontrolled (Khan et al., 2021), (Shaban & Kumar, 2016). Approximately 30% of females experience verbal aggression, compared to around 22% of males, indicating a higher allocation among females. (Shaban & Kumar, 2016). Moreover, the percentage of depression signs in young adults increased from 24% over the course of 2001–2010 to 37% within 2011–2020 (Shorey et al., 2022). Multiple researches have interlinked major mood disorders (MDD) to hormonal fluctuations (Shorey et al., 2022). The neurocentral system and the hormonal system are responsible for homeostatic control and stimulus response (Trifu et al., 2020). Recent studies have reported irregular thyroid-stimulating hormone (TSH) levels in

teenagers with MDD, whereas the additional factors along with unbound triiodothyronine (FT3), unbound thyroxin (FT4), total T3 (TT3), and total T4 (TT4) have displayed no significant abnormalities (Franjić).

Thyroid Hormones: An Overview

The hormones of thyroid gland have multidimensional functions in the development of organ and in the regulatory balance of essential biological processes like body flourishing and vitality requirements in all complex animals (Nilsson & Fagman, 2017). The organ for thyroid hormones exhibit in the front neck aimed at the merge and proclamation of hormones of thyroid: thyroxine (T4) and triiodothyronine (T3) (Song et al., 2024). It should be notable that T4 is, in reality, a precursor hormone with generally low organic action as compared to T3 (Hulbert, 2000). Conversely, T3, the naturally interactive thyroid hormone, explains almost 10% of the total endogenous thyroid hormone production (Bianco et al., 2019). T4 consist of four iodine molecules bound to a tyrosine-derived spine. T4 is a primary coordinator of brain

maturation and neural system myelin remodeling (Arianas et al., 2022). This local regulation is critical for maintaining normal brain function, as alterations in thyroid hormone action can lead to behavioral abnormalities (Stohn et al., 2018). In their absence, there is no routine upgrade or working of the central cautious approach (Song et al., 2024). Thyrotropin which is also called Thyroid-Stimulating hormone (TSH) manufactured by the hypophysis gland is the key controller of thyroid development besides functions from the post gestation to adolescence (Nilsson & Fagman, 2017). In most warm-blooded animals, the thyroid isthmus is a bilobular gland linked by an isthmic zone overpassing the proximal trachea (Nilsson & Fagman, 2017). It manifests that the morphology and anatomical posture of the thyroid have little if any purpose. The thyroid gland of human is composed of bilateral lobes and a linking isthmic region that overpass the middle line at the level of the leading two cartilaginous tracheal rings (Bhavani & Abdelmalak, 2025). They are crucial for maintaining body temperature and the routine upgrade of the respiratory center, managing energy use and oxygen consumption (Song et al., 2024). They respond to the heart by broadening the contraction of heart muscles and accelerating heart work, and moreover augmented intestinal motility, has an effect on bone remodeling, sugar homeostasis, and blood fat (Song et al., 2024).

Thyroid Dysfunction and Aggression: Clinical evidence

A research is made on offenders by Antisocial Personality Disorder (ASPD) directed that they had raised plasma planes of unrestricted thyroxine and hydrocortisone, at the same time free triiodothyronine level was substantially down (Evrensel et al., 2016). TSH can elevate throughout depression, with increased TSH levels administrating the treatment of depression challenging. So, despite the similar stress level, TSH levels may differ from one person to another (Hong & Lee, 2022). The thyroid gland also has a minor cohort of hormone producing cells named parafollicular cells. These cells are of primitive endoderm and emerge from the parafollicular cells, are of neuroendocrine nature and mainly produce calcitonin, which is a calcium lowering hormone that has a role as an indigenous inhibitor to parathormone (Nilsson & Fagman, 2017). Hypothyroidism is cited as a deprivation in secretion of thyroid hormone and its activity (Chourasiya, 2024). About 2% and 15% of the people experiences from this disease, which can be mild or extreme (Omon & Ajay, 2023). Hyperthyroidism happens from over production of thyroid hormone from the thyroid gland or ectopic thyroid tissues (Omon & Ajay, 2023). The frequency of hyperthyroidism surrounds 3:1000 and females are 8 folds increase than males to acquire it (Omon & Ajay, 2023). Hyperthyroidism or hypothyroidism. The cues are opposite: on one perspective, overproduction causes weight reduction, arrhythmia, sensitivity to warm and sweating, accelerated digestion system, and trembling (Sebastian, 2017). On the other perspective, insufficient production leads to weight increase, sensitivity to cold, impediment, weakness, and lethargy (Shahid et al., 2018).

Hypothyroidism and Aggression

Undoubtedly, hypothyroidism is commonly paired with

depression, however hyperthyroidism typically associated with irritability, psychosis, anxiety, emotional hypersensitivity, and excitement (Trauner, 2024). Hypothyroidism and hyperthyroidism both have been correlated with an elevated threat of diverse psychological disorders, covering major depressive disorder, bipolar spectrum disorder, and social anxiety disorders (ANXs) (Soheili-Nezhad et al., 2023). In another study, depression provoking situations or psychosocial stressors can affect the hypothalamic-pituitary thyroid (HPT) system, in addition to psychodynamic and physical responses (Hong & Lee, 2022). Although the HPT-axis is unresponsive to mild stress, it gives response to extreme catastrophic stress (Hong & Lee, 2022). Moreover, contradiction persists related to changes in thyroid gland in patients with aggression disorders. A research revealed that hypothyroidism was frequent in anxiety disorder patients, on the other hand an investigation found that hyperthyroidism was frequent in the same subjects (Khan et al., 2021). As the thyroid secretor is situated on the cutting-edge surface of the neckline. For this instance, the most widespread symptoms of the disease impact just this part of the body (Yuan et al., 2021). For instance, the presence of a "rounded tumor" in the front of the throat or dysphagia. A person's temperament and even mood can depend on his work. The thyroid secretor makes hormones responsible for the metabolic intensity in addition controls the cardiovascular system, gastrointestinal tract, mental, and erotic activity (Aldhalemi & Lahhob, 2024). Swelling of the thyroid secretor is 6 folds extra popular in young woman than in young men (Dehesh et al., 2025). The thyroid secretions are crucial for cognitive growth and development, and consequently, the relationship among thyroid malfunction and temper depression syndromes has been widely investigated for the previous years (Jurado-Flores et al., 2022). Currently, even changes in reference -range thyroid activity has been linked with Major depressive disorder risk in large cohort studies. It has been proposed that hormones of thyroid may stimulate the influence of antidepressants likewise trigger the response in those who are unresponsive to established treatments (Kuś et al., 2021).

Hyperthyroidism and Psychiatric Morbidity

Studies appear to imply that the surplus of thyroid hormones and hyperthyroidism instead of hypothyroidism might influence the structures of brain engaged in the control of emotions and temperament, resulting in depression (Rigó). Furthermore, thyroid malfunction has been related to the suicidality in numerous psychological disorders including emotional disorders and psychotic disorders (Gokcay et al., 2022). An investigation reveals that elevated hostility levels are interlinked with decrease T3/T4 rate in suicidal crises; an unstable personality that may enhance aggression (Trifu et al., 2020). Here are rare findings that show a relationship flanked by thyroid hormone echelons in serum and aggression and propensity to go for an offense. Cortisol, testosterone, and thyroxine echelons were seemed to be markedly elevated in persons having disruptive behavior disorder. The escalating incidences of

thyroid dysfunction and MDD in adolescents demands investigation in this area (Osuna et al., 2024). This response will explore the complicated association among thyroid hormones and aggression, examining the underlying neuroendocrine mechanisms, potential clinical implications, and areas requiring further research.

Neuroendocrine Mechanisms Associated with Thyroid Hormones and Aggression

The mechanisms of neuroendocrine structure which influences thyroid hormones and aggression are multidimensional and involve collaboration with various neurotransmitter systems and brain regions (Raji et al., 2025).

Role of Thyroid Hormones in Neurodevelopment

Thyroid hormones primarily, T3 in addition T4 perform an essential function in regulation of brain development, markedly during the prenatal and perinatal phases (Ahmed et al., 2008). The embryonic thyroid gland grows functional afterward second trimester, so initial brain development relies completely on motherly Thyroid hormone delivery (de Escobar et al., 2004). Also minor pregnancy-related hypothyroidism can weaken prenatal neurodevelopment (Korevaar et al., 2016). Along its effects on mandatory genes that shape, develop and structure the brain, the hormones of thyroid are vital for neurodevelopment of humans (Rovet, 2014). These hormones affect the differentiation, proliferation and relocation of neurons, along with the development of neuronal networks (Bernal, 2005). T3, the naturally functional form, attaches to receptors of nucleus (TR α and TR β) in the brain, influencing the growth of the hippocampus, cerebellum and cerebral cortex (De Groot et al., 2015). The hormones of Thyroid gland have been involved in the emotional processing regulation, especially in the scenario of anger (Yilmazer, 2024). The neuroendocrine processes implicating this relationship include the thyroid hormone effect on the function and growth of intelligence areas included in emotional control, like the hippocampus, prefrontal cortex and amygdala (Popova et al., 2018). Researches have revealed that insufficiency of thyroid hormones, even minimal, can result in mental decline, abnormal behaviors, and abnormal brain anatomy (Henrichs et al., 2010). Investigation has revealed that changes in thyroid hormone concentrations, even at normal value, can effect emotional processing and enhance the predisposition for aggression (Wirth et al., 2013). Molecular fluctuations in the brain, mainly the prefrontal cortex and hypothalamus, interrelated to thyroid hormone beckoning, together with reformed countenance of the Ttr gene and protein, Thyroid hormone trailers and enzymes, TH echelons, and TH-responsive genes (Rawat et al., 2021). In contrast, sufficient thyroid hormone concentrations are crucial towards the typical growth of hippocampus, cerebral cortex, and other regions of brain (Ausó et al., 2004). Illustrating the processes by which thyroid hormones regulate emotional processing and aggression will give in-depth perspectives into the development of new therapeutic measures for the regulation of aggression-linked disorders.

Table 1

Critical Role of Thyroid Hormones in Neurodevelopment

Processes	Role of Thyroid Hormones	Effects of Deficiency
Neurogenesis (Kapri et al., 2022)	Triggers proliferation of neural progenitors	Deficiency of neuron production
Neurotransmitters (Singh & Sundaresh, 2022)	Controls dopamine/serotonin systems	Behavioral / mood disorders
Neuronal Migration (Salas-Lucia, 2024)	Directs cortical layering	Chaotic brain structure
Myelination (Pagnin et al., 2021)	Supports maturation of oligodendrocytes	Reduced nerve signaling
Synaptogenesis (Chakrabarti et al., 2023)	Increases synaptic connections	Memory / learning scarcity

Neuroendocrine Stress Response System (Hypothalamic-Pituitary-Adrenal Axis)

The neuroendocrine stress response system (HPA) Axis has an important function in controlling responses of stress and regulation of emotions, which are deeply connected to behavior of aggressiveness. Instability of the HPA axis, accompanied by modified excretion of cortisol, has been interlinked with enhanced hostility and impulsivity (Smith & Vale, 2006). Notably, hormones of thyroid thyroxine (T₄) and triiodothyronine (T₃) collaborate with the HPA axis, affecting its function and, subsequently, aggression-related attitudes (Fekete & Lechan, 2014). Hyperthyroidism, characterized by increased levels of THs, has been interlinked to high reactivity of HPA axis, actively exhibiting sensitivity of stress and tendencies of aggressive behavior (Nikolidaki, 2023). On the other hand, hypothyroidism may cause blunting of HPA axis, participating in mood depressing that subtly affect aggression (Samuels, 2014). Moreover, THs regulate expression of glucocorticoid receptor in the brain, influencing feedback mechanisms of cortisol and guideline of expressive behavior (Paul et al., 2022). This neurological interferences proposed that thyroid instability may dispose persons to modified stress responses and dysfunctional aggression, emphasizing the necessity for more research into TH-HPA axis engagement in aggressive phenotypes (Terburg et al., 2018).

Neurotransmitter Systems

Thyroid hormones communicate with different neurotransmitter systems contributing in the control of aggressive mechanisms, involving the dopaminergic, GABAergic and serotonergic systems (Narvaes & Martins de Almeida, 2014), (Cocco et al., 2023).

Serotonin

Serotonin, a primary regulator of aggression and impulse control, is suppressed in hypothyroidism, which may participate to enhanced impulsive aggression and irritability (Raji et al., 2025).

Dopamine

hyperthyroidism has been interlinked to increase dopamine activity in the limbic pathway, actively enhancing goal-oriented and hostile behaviors (Raji et al., 2025).

GABA

Thyroid hormones control neurotransmission of GABAergic activity, with thyroid malfunction modifying

expression of GABA receptor and restrictive mode in the amygdala, a region of brain crucial for regulation of aggression (Sturmeay, 2022).

Androgens

Investigation proposes an intricate relationship between androgens, thyroid hormones, and aggression. Raised FT3 echelons were connected with augmented aggression in people with Antisocial Personality Disorder (APD), predominantly in illicit subcategories (Evrensel et al., 2016). Thyroid hormones intermingle with receptors of androgens, manipulating their countenance and androgen biogenesis, while androgens may also disturb thyroid-related genes (Torabinejad et al., 2023). Thyroid hormones correspondingly have a title part in the instruction of enzymes tangled in the biogenesis of androgenic hormone, like androgen-converting enzyme, which is important in the modification of male sex hormone into its dynamic form, Dihydrotestosterone (Torabinejad et al., 2023).

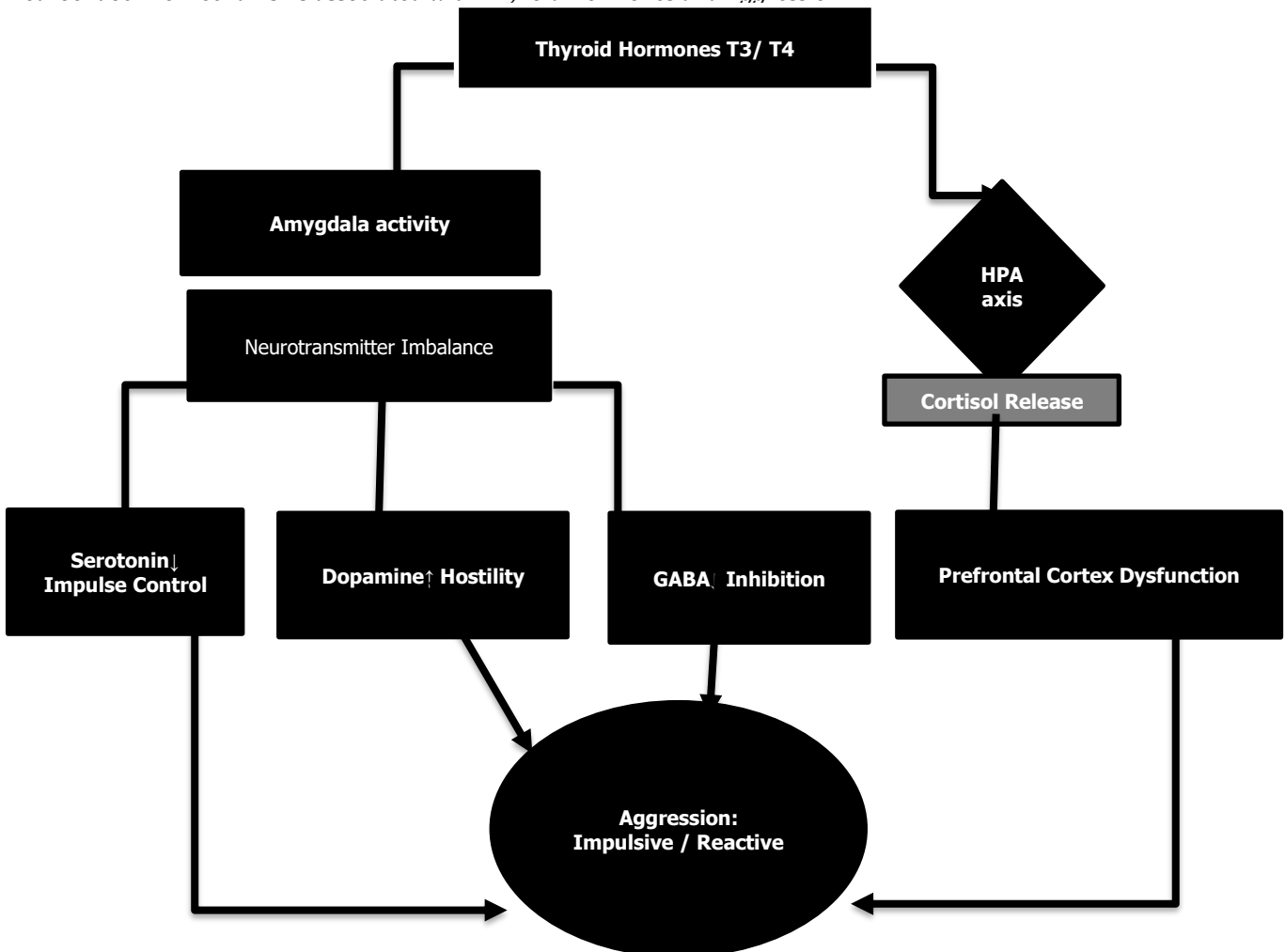
Thyroid Hormones and Amygdala

The amygdala is a well-known spot for memory formation of fear, and medical revisions propose contribution of hormone signing falls in progress of traumatic disorders (Maddox et al., 2025). The amygdala, a perilous region of brain for expressive dispensation and threat comeback, is predisposed by thyroid hormones (THs), which may

control aggressive behavior (Mbiydzenyuy & Qulu, 2024). Investigate directs that triiodothyronine (T₃) and thyroxine (T₄) disturb amygdala responsiveness and neuroplasticity, changing emotional parameter and aggressive behavior (Maddox et al., 2025). A 2024 research initiate that Hyperthyroidism in male rats encourages behavioral and biochemical modifications, as well as memory weakening (Makadi et al., 2024). Study advises that hypothyroidism and impulsive aggression are related to changed practical connectivity in the brain. Hypothyroidism decreases connectivity in frontoparietal, visual, and motor systems (Singh et al., 2015). Thyroid hormones also adjust serotonergic and GABAergic communication in the amygdala, which are crucial machineries in aggression intonation (Siegel et al., 2007). Small base line T echelons have been connected with augmented aggression in women, facilitated by basolateral amygdala (BLA) connectivity to the superior temporal gyrus (Buades-Rotger et al., 2019) Contrariwise, advanced free T3 points associated with larger aggression in people with Antisocial Personality Disorder (Evrensel et al., 2016). These conclusions climax the amygdala as a life-threatening arbitrator of thyroid-related aggression, justifying more enquiry into THs as latent biomarkers or therapeutic marks.

Figure 1

Neuroendocrine Mechanisms associated with Thyroid Hormones and Aggression



Clinical and Observational Studies exploring the Association between Thyroid Hormones and Aggressive Behavior

Table 2 grants a inclusive swift of medical revisions probing the relationship between thyroid hormone heights and aggressive behavior diagonally in various peoples. The comprised research establishes important

associations between reformed thyroid function (both hyperthyroidism and hypothyroidism) and amplified aggression, as restrained through social observations, homogenous surveys (e.g., Buss-Perry Aggression Questionnaire), and biological calculations of thyroid markers (TSH, FT3, FT4).

Table 2
Association of Thyroid Hormones with Aggressive behavior

References	Study Design	Sample Size	Thyroid Hormones	Aggression	Association	Conclusion
(HAZAR et al., 2018)	Cross-sectional study	25male athletes	T4, T3 TSH	Behavioral observation	YES	Athletes’ aggressive behaviors are associated with thyroid hormones having significant differences, statistically.
(Popova et al., 2018)	Cross-Sectional study	32male students	T3, T4, and Cortisol	Questionnaire	YES	Aggression is associated with thyroid hormones, but indirectly, through neuroticism
(Gokcay et al., 2022)	Case-Control study	Sixty patients with various psychiatric diagnosis (30 males and 30 females) and 60 healthy subjects	Thyroid hormones, albumin	Buss-Perry Aggression Questionnaires	YES	there is a strong association of suicidal behavior, aggression traits with thyroid dysfunction
(Acar & Ulgen, 2020)	Case- control study	208 male volunteers who were imprisoned and 82 male volunteers who were not imprisoned.	Thyroid hormone levels (T3, T4, TSH), the ratio of T3/T4 and pulse rate	Crime rate observational study		Substantial surge in T3 and T4 heights and the occurrence of lethal thyromegaly were related with aggression-related misconduct.
(Evrensel et al., 2016)	Case- control study	96 subjects with a diagnosis of antisocial personality disorder and 97 people as a controller set	Thyroid function tests	Buss-Perry Aggression Questionnaire	The illicit and noncriminal APD groups actually show different properties	Higher thyroid hormone levels, particularly free T3 are related to the amplified aggression in persons with Anti-social personality disorder.
(Pankowski et al., 2021)	Cross-Sectional study	354 women	period since their hypothyroidism was analyzed, TSH, FT3 and FT4 echelons with parts from tests accomplished not previous than 30 days earlier contributing in the study.	questionnaires	The study initiates a relationship among the harshness of expressive anguish indications and illness-related opinions.	Emotional features appear to show a significant part in the growth of signs of unhappiness, nervousness, and fury in patient role with hypothyroidism.
(Emir et al., 2022)	Observational study	115 patients who presented in HSFP and 115 healthy controls.	TSH, serum free T3 and T4 levels	interview	YES	The current study established that blood serum thyroid hormone echelons of people who devoted illegal crimes could be related to the impulsivity and hostility; though, additional trainings are obligatory for explanation.
(Herda et al., 2021)	Retrospective study	243 patients, 193 females and 50 males	Thyroid disease	Secondary data collection	YES	There is a closeness between thyroid disease incidences and mental health illness, involving behavioral disorders.

Cooperatively, these revisions disclose discrete outlines connecting thyroid dysfunction to aggression. Higher T3/T4 echelons are connected to imprudent and fierce behaviors, predominantly in criminal inhabitants (Acar & Ulgen, 2020; Evrensel et al., 2016), while hypothyroidism associates with anger and emotional dysfunction, especially in women (Pankowski et al., 2021). Remarkably, the harshness of aggression often resembles to the gradation of thyroid inequity, signifying a dose-dependent association. These results underline the possible part of thyroid screening in risky assemblies (e.g., persons with antisocial characters or mood disorders) and highpoint the necessity for additional investigate into thyroid-modulating rehabilitations for managing aggression.

Sex Modifications in Thyroid-Hormones Accompanying Aggression

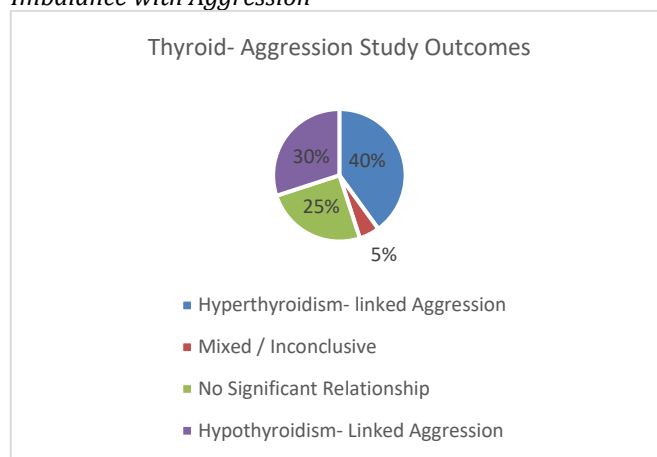
Evolving suggestion highpoints noteworthy gender alterations in the connotation among thyroid dysregulation and aggression, probably determined by hormonal, neuroanatomical, and sociocultural aspects. It is no wonder that women these days experience a heap of health encounters. Thyroid dysregulations, which are principally produced by an inequity of thyroid hormones are rising more common, with the American Thyroid Association approximating that one out of every eight women folk may face thyroid contests over her life time (Farooqi et al., 2023). Women are more predisposed to to thyroid conditions e.g., Hashimoto’s thyroiditis, among 2.0

and 7.0 times advanced occurrence than men (Vargas-Uricoechea et al., 2025). Thyroid autoimmune diseases, with Graves' disease and Hashimoto's thyroiditis, are more public in females than males (Ovčariček et al., 2024). These dissimilar incidences may hinge on alterations in affected role behavior and in thyroid inquiries. Nevertheless, an influence on sensual hormones is expected, though this has been inadequately explained (Suteau et al., 2021). Female sex hormone may surge the engineering of mutagenic jots in the thyroid cubicle and indulge the propagation and incursion of tumor compartments by modifying both the enzymatic apparatus of thyrocytes and the provocative process related to cancer progress (Święchowicz et al., 2022). Conversely, the inferior diagnosis of thyroid tumor related with the masculine gender is off-color explained (Suteau et al., 2021). Gender variances in aggression have also been detected, with men displaying uniformly additional violence than females at the equal heights of external fury countenance (Kim et al., 2022). Aggression is related to characteristic anger in men but not women, contempt alike heights of aggression (Fahlgren et al., 2022). For example, higher T₄ in men with Antisocial Personality Disorder associates with impulsivity and violent conduct (Evrensel et al., 2016), while hypothyroid women more commonly extant with adopting symptoms (e.g., irritability, depression) (Pankowski et al., 2022). Thyroid hormones could also be ace of the main gesticulating particles to control diverse brain beckoning in a man- and woman-definite means (Baksi & Pradhan, 2021). Thyroid hormone controls nervous system function in a sex-specific method, with males trusting more on amygdala-mediated aggression paths moderated by T₃ and females displaying solidier serotonin-dependent rule (Baksi & Pradhan, 2021). Moreover, estrogen's variation of thyroid receptor countenance may bumper aggression in women (Brown et al., 2023). Additional investigation must unravel biotic (e.g., TH-sex hormone interaction) from psychosocial effects (e.g., gender parts in anger expression) to improve sex-tailored interferences.

REFERENCES

1. Acar, H., & Ulgen, A. (2020). Relationship between thyroid hormone levels and crime type: a controlled study in prisoners. *International journal of endocrinology*, 2020(1), 9172134. <https://doi.org/10.1155/2020/9172134>
2. Ahmed, O. M., El-Gareib, A., El-Bakry, A., Abd El-Tawab, S., & Ahmed, R. (2008). Thyroid hormones states and brain development interactions. *International journal of developmental neuroscience*, 26(2), 147-209. <https://doi.org/10.1016/j.ijdevneu.2007.09.011>
3. Aldhalemi, A. A., & Lahhob, Q. R. (2024). The study of chemical reactions in the human body through the use of hormones. *International Journal of Advanced Biochemistry Research*, 8(5), 01-09. <https://doi.org/10.33545/26174693.2024.v8.i5a.1048>
4. Arianas, G. K., Kostopoulou, E., Ioannidis, A., Dimopoulos, I., Chiotis, C., Prezerakos, P., Spiliotis, B. E., & Rojas Gil, A. P. (2022). Emotional intelligence scores in children and adolescents with subclinical hypothyroidism—correlation with serum serotonin and thyroid-stimulating hormone (TSH) concentrations. *Hormones*, 1-8. <https://doi.org/10.1007/s42000-021-00320-3>

Figure 1
Neuroendocrine Mechanisms Linking Thyroid Hormones Imbalance with Aggression



CONCLUSION

The evaluation forms a prevailing association between thyroid hormone dysfunction and aggression, interceded by complex neuroendocrine and neurotransmitter mechanisms. Mutually hyperthyroidism and hypothyroidism suggestively disturb emotional regulation and control of conduct, as showed, and may possibly aggravate aggression, particularly in patients with pre-existing psychiatric instabilities. Gender-specific designs also specify that males and females might have different neuroendocrine retorts to thyroid disparity, producing gender-specific tactics suitable for both analysis and handling. Medical indication more settles the dose-response association between thyroid hormone and aggression cruelty. Longitudinal studies should be a research urgency in the imminent to found connection, join thyroid assessment into psychiatric evaluation, and examine hormone-modulating action as an assistant treatment in aggression-associated disorders. A neuroendocrine model of aggression has the possible to lead to more beset and adapted psychiatric handling.

5. Ausó, E., Lavado-Autric, R. a., Cuevas, E., Del Rey, F. E., Morreale de Escobar, G., & Berbel, P. (2004). A moderate and transient deficiency of maternal thyroid function at the beginning of fetal neocortico genesis alters neuronal migration. *Endocrinology*, 145(9), 4037-4047. <https://doi.org/10.1210/en.2004-0274>
6. Baksi, S., & Pradhan, A. (2021). Thyroid hormone: sex-dependent role in nervous system regulation and disease. *Biology of sex differences*, 12(1), 25. <https://doi.org/10.1186/s13293-021-00367-2>
7. Bernal, J. (2005). Thyroid hormones and brain development. *Vitamins & Hormones*, 71, 95-122. [https://doi.org/10.1016/s0083-6729\(05\)71004-9](https://doi.org/10.1016/s0083-6729(05)71004-9)
8. Bhavani, S. S., & Abdelmalak, B. (2025). Anatomy of the Airway/Airway Management. *Basic Sciences in Anesthesia*, 67-102. https://doi.org/10.1007/978-3-031-60203-0_4
9. Bianco, A. C., Dumitrescu, A., Gereben, B., Ribeiro, M. O., Fonseca, T. L., Fernandes, G. W., & Bocco, B. M. (2019). Paradigms of dynamic control of thyroid hormone signaling. *Endocrine reviews*, 40(4), 1000-1047. <https://doi.org/10.1210/er.2018-00275>

10. Brown, E. D., Obeng-Gyasi, B., Hall, J. E., & Shekhar, S. (2023). The thyroid hormone axis and female reproduction. *International Journal of Molecular Sciences*, 24(12), 9815. <https://doi.org/10.3390/ijms24129815>
11. Buades-Rotger, M., Engelke, C., & Krämer, U. M. (2019). Trait and state patterns of basolateral amygdala connectivity at rest are related to endogenous testosterone and aggression in healthy young women. *Brain imaging and behavior*, 13, 564-576.
12. Chakrabarti, N., Sarkar, P. K., Ray, A. K., & Martin, J. V. (2023). Unveiling the nongenomic actions of thyroid hormones in adult mammalian brain: The legacy of Mary B. Dratman. *Frontiers in Endocrinology*, 14, 1240265. <https://doi.org/10.3389/fendo.2023.1240265>
13. Chourasiya, S. (2024). THE ROLE OF OXIDATIVE STRESS IN HUMAN PATHOLOGY WITH A SPECIAL ATTENTION TO THYROID DISORDERS. *Frontiers in Animal Science: Research and Development Volume I*, 45.
14. Cocco, R., Arfuso, F., Giannetto, C., Piccione, G., Cesarani, A., Pulina, G., & Sechi, S. (2023). A preliminary study on the interplay between the serum levels of neurotransmitters and thyroid hormones for the evaluation of the behavioral phenotype of dogs. *Animals*, 13(3), 411.
15. de Escobar, G. M., Obregón, M. a. J., & del Rey, F. E. (2004). Maternal thyroid hormones early in pregnancy and fetal brain development. *Best practice & research Clinical endocrinology & metabolism*, 18(2), 225-248. <https://doi.org/10.1016/j.beem.2004.03.012>
16. De Groot, L., Chrousos, G., & Dungan, K. (2015). Thyroid Hormones in Brain Development and Function. *Endotext-NCBI Bookshelf*, 2000, 1-62.
17. Dehesh, T., Mosleh-Shirazi, M. A., & Dehesh, P. (2025). Prevalence and associated factors of anxiety and depression among patients with hypothyroidism in Southern Iran. *BMC psychiatry*, 25(1), 54. <https://doi.org/10.1186/s12888-025-06490-3>
18. Emir, B. S., Yildiz, S., Kılıçşan, A. K., Kurt, O., & Gözel, N. (2022). The correlations between serum thyroid hormone levels, crime, impulsivity and aggression in high-security forensic psychiatry service patients. *Turkish Journal of Health Science and Life*, 5(3), 174-181.
19. Evrensel, A., Ünsalver, B. Ö., & Özşahin, A. (2016). The relationship between aggression and serum thyroid hormone level in individuals diagnosed with antisocial personality disorder. *Nöro Psikiyatri Arşivi*, 53(2), 120.
20. Fahlgren, M. K., Cheung, J. C., Ciesinski, N. K., McCloskey, M. S., & Coccaro, E. F. (2022). Gender differences in the relationship between anger and aggressive behavior. *Journal of Interpersonal Violence*, 37(13-14), NP12661-NP12670. <https://doi.org/10.1177/0886260521991870>
21. Farooqi, S., Raj, S., Koyfman, A., & Long, B. (2023). High risk and low prevalence diseases: Thyroid storm. *The American journal of emergency medicine*, 69, 127-135.
22. Fekete, C., & Lechan, R. M. (2014). Central regulation of hypothalamic-pituitary-thyroid axis under physiological and pathophysiological conditions. *Endocrine reviews*, 35(2), 159-194. <https://doi.org/10.1210/er.2013-1087>
23. Franjić, S. Thyroid Hormones are Essential for Normal Life. *Endocrinology and Dysfunctions*, 1(1).
24. Gokcay, H., Balcioglu, Y. H., & Solmaz, M. (2022). The Role of Impulsive and Aggressive Traits, Albumin and Thyroid Functions in Recent Suicide Attempters: An Investigation with a Transdiagnostic Approach. *Neurochemical Journal*, 16(4), 491-497.
25. HAZAR, M., BEYLEROĞLU, M., YALÇIN, S., & ÇETİN, O. (2018). INVESTIGATION OF THE RELATIONSHIP BETWEEN ATHLETES AGGRESSIVE BEHAVIORS AND THYROID HORMONES. *Ovidius University Annals, Series Physical Education & Sport/Science, Movement & Health*, 18(1).
26. Henrichs, J., Bongers-Schokking, J. J., Schenk, J. J., Ghassabian, A., Schmidt, H. G., Visser, T. J., Hooijkaas, H., de Muinck Keizer-Schrama, S. M., Hofman, A., & Jaddoe, V. V. (2010). Maternal thyroid function during early pregnancy and cognitive functioning in early childhood: the generation R study. *The Journal of Clinical Endocrinology & Metabolism*, 95(9), 4227-4234. <https://doi.org/10.1210/jc.2010-0415>
27. Herda, J., Okoński, P., Parfin, A., Wdowiak, K., & Kos, M. (2021). Thyroid diseases and mental illness together with behavioural disorders versus mental illness together with behavioural disorders and thyroid diseases. *Polish Journal of Public Health*, 131, 35-40.
28. Hong, H., & Lee, J. (2022). Thyroid-stimulating hormone as a biomarker for stress after thyroid surgery: a prospective cohort study. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*, 28, e937957-937951.
29. Hulbert, A. (2000). Thyroid hormones and their effects: a new perspective. *Biological Reviews*, 75(4), 519-631.
30. Jurado-Flores, M., Warda, F., & Mooradian, A. (2022). Pathophysiology and clinical features of neuropsychiatric manifestations of thyroid disease. *Journal of the Endocrine Society*, 6(2), bvab194. <https://doi.org/10.1210/jendso/bvab194>
31. Kapri, D., Fanibunda, S. E., & Vaidya, V. A. (2022). Thyroid hormone regulation of adult hippocampal neurogenesis: Putative molecular and cellular mechanisms. In *Vitamins and Hormones* (Vol. 118, pp. 1-33). Elsevier.
32. Khan, A., Ullah, H., & Iftikhar, S. (2021). GENDER DIFFERENCES AND AGGRESSION: A COMPARATIVE STUDY OF YOUNG AND ADULT ATHLETES. *Journal of Social Research Development*, 02, 49-53. <https://doi.org/10.53664/JSRD/02-01-2021-05-49-53>
33. Kim, D., Liu, Q., Quartana, P. J., & Yoon, K. L. (2022). Gender differences in aggression: A multiplicative function of outward anger expression. *Aggressive behavior*, 48(4), 393-401.
34. Korevaar, T. I., Muetzel, R., Medici, M., Chaker, L., Jaddoe, V. W., de Rijke, Y. B., Steegers, E. A., Visser, T. J., White, T., & Tiemeier, H. (2016). Association of maternal thyroid function during early pregnancy with offspring IQ and brain morphology in childhood: a population-based prospective cohort study. *The lancet Diabetes & endocrinology*, 4(1), 35-43.
35. Kuś, A., Kjaergaard, A. D., Marouli, E., Del Greco M, F., Sterenborg, R. B., Chaker, L., Peeters, R. P., Bednarczuk, T., Åsvold, B. O., & Burgess, S. (2021). Thyroid function and mood disorders: a Mendelian randomization study. *Thyroid*, 31(8), 1171-1181. <https://doi.org/10.1089/thy.2020.0884>
36. Maddox, S. A., Ponomareva, O. Y., Zaleski, C. E., Chen, M. X., Vella, K. R., Hollenberg, A. N., Klengel, C., & Ressler, K. J. (2025). Evidence for thyroid hormone regulation of amygdala-dependent fear-relevant memory and plasticity. *Molecular Psychiatry*, 30(1), 201-212.
37. Makadi, M., Ibrahim, I. A., Bahr, H. I., Elbaz, B. A., & Mahmoud, Y. K. (2024). The Biochemical and Behavioral Alterations Induced by Experimental Hyperthyroidism in Male Rats. *Suez Canal Veterinary Medical Journal. SCVMJ*.
38. Mbiydzennyuy, N. E., & Qulu, L.-A. (2024). Stress, hypothalamic-pituitary-adrenal axis, hypothalamic-pituitary-gonadal axis, and aggression. *Metabolic brain disease*, 1-24. <https://doi.org/10.1007/s11011-024-01393-w>
39. Munley, K. M., Rendon, N. M., & Demas, G. E. (2018). Neural androgen synthesis and aggression: insights from a

- seasonally breeding rodent. *Frontiers in Endocrinology*, 9, 136.
40. Narvaes, R., & Martins de Almeida, R. M. (2014). Aggressive behavior and three neurotransmitters: dopamine, GABA, and serotonin—A review of the last 10 years. *Psychology & Neuroscience*, 7(4), 601.
<https://doi.org/10.3922/j.psns.2014.4.20>
 41. Nikolidaki, M. (2023). *Hypothalamic-Pituitary-Thyroid (HPT) Axis and Affective Disorders. A Systematic Review* European University of Cyprus (Cyprus)].
 42. Nilsson, M., & Fagman, H. (2017). Development of the thyroid gland. *Development*, 144(12), 2123-2140.
 43. Omon, E. A., & Ajay, O. D. (2023). Oxidative stress and antioxidant markers in individuals with thyroid hormones dysfunction. *European Journal of Clinical and Experimental Medicine*(4), 768-775.
 44. Osuna, E., Baumgartner, J., Walther, A., Emery, S., Albermann, M., Baumgartner, N., Schmeck, K., Walitza, S., Strumberger, M., & Hersberger, M. (2024). Investigating thyroid function and iodine status in adolescents with and without paediatric major depressive disorder. *British Journal of Nutrition*, 132(6), 725-737.
<https://doi.org/10.1017/s0007114524001910>
 45. Ovcariček, P. P., Görges, R., & Giovanella, L. (2024). Autoimmune thyroid diseases. *Seminars in nuclear medicine*,
 46. Pagnin, M., Kondos-Devic, D., Chincarini, G., Cumberland, A., Richardson, S. J., & Tolcos, M. (2021). Role of thyroid hormones in normal and abnormal central nervous system myelination in humans and rodents. *Frontiers in neuroendocrinology*, 61, 100901.
 47. Pankowski, D., Wytrychiewicz-Pankowska, K., Janowski, K., Pisula, E., & Fal, A. (2022). General and Illness-Specific Predictors of Adaptation to Chronic Illnesses: Cognitive Appraisals and Illness-related Beliefs. *Advances in Cognitive Psychology*, 18(2).
 48. Pankowski, D., Wytrychiewicz-Pankowska, K., Janowski, K., Pisula, E., & Walicka, M. (2021). The role of illness-related beliefs in depressive, anxiety, and anger symptoms: an on-line survey in women with hypothyroidism. *Frontiers in Psychiatry*, 12, 614361.
<https://doi.org/10.3389/fpsy.2021.614361>
 49. Paul, S. N., Wingenfeld, K., Otte, C., & Meijer, O. C. (2022). Brain mineralocorticoid receptor in health and disease: From molecular signalling to cognitive and emotional function. *British journal of pharmacology*, 179(13), 3205-3219.
 50. Popova, L., Vasylyeva, I., Nakonechnaya, O., & Vashchuk, M. (2018). Thyroid hormones role in neuroticism formation and aggression development.
 51. Raji, H., Dinesh, S., & Sharma, S. (2025). Inside the impulsive brain: a narrative review on the role of neurobiological, hormonal and genetic factors influencing impulsivity in psychiatric disorders. *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, 61(1), 4.
 52. Rawat, R. S., Bhambri, A., Pal, M., Roy, A., Jain, S., Pillai, B., & Konar, A. (2021). Early life trauma leads to escalated aggressive behavior and its inheritance by impairing thyroid hormone availability in brain. *bioRxiv*, 2021.2007.2005.448713.
<https://doi.org/10.7554/elife.77968>
 53. Rigó, A. HASHIMOTO'S THYROIDITIS IN HEALTH PSYCHOLOGICAL APPROACH. *CLINICAL HEALTH PSYCHOLOGY IN PRACTICE*, 59.
 54. Rovet, J. F. (2014). The role of thyroid hormones for brain development and cognitive function. *Endocr Dev*, 26(26), 26-43.
 55. Salas-Lucia, F. (2024). Mapping thyroid hormone action in the human brain. *Thyroid*, 34(7), 815-826.
 56. Samuels, M. H. (2014). Psychiatric and cognitive manifestations of hypothyroidism. *Current Opinion in Endocrinology, Diabetes and Obesity*, 21(5), 377-383.
 57. Sebastian, S. (2017). *A Comparative Study on Physiological Taste Threshold in Hypo and Hyperthyroidism* Rajiv Gandhi University of Health Sciences (India)].
 58. Shaban, N., & Kumar, P. (2016). Young Adults and Aggression: A Comparative Study of Gender Differences. *The International Journal of Indian Psychology*, 3, 106-114.
<https://doi.org/10.25215/0304.031>
 59. Shahid, M. A., Ashraf, M. A., & Sharma, S. (2018). Physiology, thyroid hormone.
 60. Shorey, S., Ng, E. D., & Wong, C. H. (2022). Global prevalence of depression and elevated depressive symptoms among adolescents: A systematic review and meta-analysis. *British Journal of Clinical Psychology*, 61(2), 287-305.
 61. Siegel, A., Bhatt, S., Bhatt, R., & Zalcman, S. S. (2007). The neurobiological bases for development of pharmacological treatments of aggressive disorders. *Current neuropharmacology*, 5(2), 135-147.
<https://doi.org/10.2174/157015907780866929>
 62. Singh, B., & Sundaresh, V. (2022). Thyroid hormone use in mood disorders: revisiting the evidence. *The Journal of Clinical Psychiatry*, 83(5), 42331.
 63. Singh, S., Kumar, M., Modi, S., Kaur, P., Shankar, L., & Khushu, S. (2015). Alterations of functional connectivity among resting-state networks in hypothyroidism. *Journal of neuroendocrinology*, 27(7), 609-615.
 64. Smith, S. M., & Vale, W. W. (2006). The role of the hypothalamic-pituitary-adrenal axis in neuroendocrine responses to stress. *Dialogues in clinical neuroscience*, 8(4), 383-395.
 65. Soheili-Nezhad, S., Sprooten, E., Tendolkar, I., & Medici, M. (2023). Exploring the genetic link between thyroid dysfunction and common psychiatric disorders: a specific hormonal or a general autoimmune comorbidity. *Thyroid*, 33(2), 159-168.
<https://doi.org/10.1089/thy.2022.0304>
 66. Song, X., Yan, S., Lai, S., Zhang, Y., Wang, Y., He, J., Huang, D., Zhang, J., Lu, X., & Chen, G. (2024). Gender differences of neurometabolic and neuroendocrine alternations and its lateralization in adolescents with major depressive disorder. *BMC psychiatry*, 24(1), 949.
 67. Stohn, J. P., Martinez, M. E., Zafer, M., López-Espíndola, D., Keyes, L. M., & Hernandez, A. (2018). Increased aggression and lack of maternal behavior in Dio3-deficient mice are associated with abnormalities in oxytocin and vasopressin systems. *Genes, Brain and Behavior*, 17(1), 23-35.
 68. Sturmey, P. (2022). Biological evolution of violence and aggression. II: Brains, neurotransmitters, and hormones. In *Violence and Aggression: Integrating Theory, Research, and Practice* (pp. 121-143). Springer.
https://doi.org/10.1007/978-3-031-04386-4_5
 69. Suteau, V., Munier, M., Briet, C., & Rodien, P. (2021). Sex bias in differentiated thyroid cancer. *International Journal of Molecular Sciences*, 22(23), 12992.
 70. Świąchowicz, B., Kasielska-Trojan, A., Manning, J. T., & Antoszewski, B. (2022). Can digit ratio (2D: 4D) be indicative of predispositions to autoimmune thyroid diseases in women-Hashimoto thyroiditis and Graves' disease? *Frontiers in Endocrinology*, 13, 914471.
 71. Terburg, D., Scheggia, D., Del Rio, R. T., Klumpers, F., Ciobanu, A. C., Morgan, B., Montoya, E. R., Bos, P. A., Giobellina, G., & van den Burg, E. H. (2018). The basolateral amygdala is essential for rapid escape: a human and rodent study. *Cell*, 175(3), 723-735. e716.
<https://doi.org/10.1016/j.cell.2018.09.028>
 72. Torabinejad, S., Miro, C., Barone, B., Imbimbo, C., Crocetto, F., & Dentice, M. (2023). The androgen-thyroid hormone

- crosstalk in prostate cancer and the clinical implications. *European thyroid journal*, 12(3).
73. Trauner, D. A. (2024). Cognitive and Behavioral. *Pediatric Behavioral Neurology*, 251.
<https://doi.org/10.1201/9781003574088-10>
74. Trifu, S. C., Tudor, A., & Radulescu, I. (2020). Aggressive behavior in psychiatric patients in relation to hormonal imbalance. *Experimental and therapeutic medicine*, 20(4), 3483-3487.
<https://doi.org/10.3892/etm.2020.8974>
75. Vargas-Uricoechea, H., Castellanos-Pinedo, A., Urrego-Noguera, K., Pinzón-Fernández, M. V., Meza-Cabrera, I. A., & Vargas-Sierra, H. (2025). A Scoping Review on the Prevalence of Hashimoto's Thyroiditis and the Possible Associated Factors. *Medical Sciences*, 13(2), 43.
<https://doi.org/10.3390/medsci13020043>
76. Wirth, M. M., Gaffey, A. E., & Work, H. (2013). Hormones and emotion. *Handbook of cognition and emotion*, 69.
77. Yilmazer, E. (2024). Hormonal Underpinnings of Emotional Regulation: Bridging Endocrinology and Psychology. *The Journal of Neurobehavioral Sciences*, 11(2), 60-75.
<https://doi.org/10.32739/uha.jnbs.11.1539123>
78. Yuan, H., Zhao, J., Xie, E., Yi, L., Zheng, Z., Geng, J., Yuan, H., Zhao, J., Xie, E., & Yi, L. (2021). Endocrine and Metabolic Diseases. In *Clinical Molecular Diagnostics* (pp. 665-716). Springer.
https://doi.org/10.1007/978-981-16-1037-0_40