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Prevalence of Hyperthyroidism and Hypothyroidism via Age and Gender Using TSH as a Molecular Biomarker

Usama[1], Talha Ramzan[2], Muhammad Shahzaib Rasheed[3], Azka Sabir[4*], Shams-ur-Rehman[2]

[1]Department of Biotechnology, Islamia University of Bahawalpur (IUB), Pakistan
[2]Department of Pharmacy, The Next Institute of Science and Technology (NIST) Multan, Pakistan
[3]Department of Pharmacy, Bahauddin Zakariya University (BZU) Multan, Pakistan
[4]Department of Pharmacology, Faculty of Pharmacy, Bahauddin Zakariya University (BZU) Multan, Pakistan

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***Corresponding author:** Azka Sabir
Department of Pharmacology, Faculty of Pharmacy, Bahauddin Zakariya University (BZU) Multan, Pakistan

Abstract **Original Research Article**

Background: Endocrine diseases including thyroid disorders are one of the important issues arising in the population as they tend to affect the normal functioning of the human body. The study aimed to understand the prevalence of the two main disorders, hyperthyroidism and hypothyroidism, in females and males. ***Methods:*** Data were collected using self-report method and laboratory record. The cross-sectional method of analysis was used, incorporating the participants who are to undergo regular thyroid functional examination. The participants were grouped according to age and gender and the thyroid status was grouped according to the standard TSH reference ranges. Hypo and hyperthyroidism was prevalence analyzed in order to reveal the demographic trends and risk categories. A comparative approach was used to understand the thyroid disorders prevalence between both genders. ***Results:*** We found that females are more prone to develop thyroid disorders compared to males. An age-wise approach was also used to know the age relation with thyroid disorders. The results indicated no positive correlation between increasing age and thyroid disorders. These disorders can occur at any age influenced by many factors. Middle-aged people of both genders showed a higher tendency toward thyroid disorders. Hypothyroidism was the leading disorder when results were analyzed as compared to hyperthyroidism. ***Conclusion:*** TSH is an ideal population-based screening and early detection of thyroid disorders molecular biomarker. The noted age and gender specific differences demonstrate the necessity of screening strategies that are focused on the population, particularly, the high-risk group. Here early detection and treatment of thyroid dysfunction can go a long way in reducing morbidity and increasing the overall quality of life.

Keywords: Hyperthyroidism, Hypothyroidism, Thyroid stimulating hormone (TSH), Molecular Biomarker, triiodothyronine (T3), and thyroxine (T4).

1. INTRODUCTION

The first endocrine gland which develops in human is the thyroid gland, basically originating from a diverticulum, whose position in human body is the median ventral wall of pharynx also known as thyroid diverticulum (Benvenga *et al.,* 2018). Like all the other glands which comes under the endocrine system, thyroid gland also involves the feedback mechanism controlled by the pituitary, hypothalamus, and the targeted gland. Thyroid is made up of two types of cell, follicular and para-follicular. Follicular cells are mainly responsible for secretion of the thyroid hormones such as triiodothyronine (T3) and thyroxine (T4), while the para-follicular, which are also called C-cells, are responsible for the secretion of the calcitonin which regulates the calcium (Chiasera, 2013). Thyroid hormones are considered important for the normal or optimal functioning of almost all types of tissues. Metabolic activity, consumption of oxygen, differentiation and growth are primarily controlled by thyroid hormones (Dev *et al.,* 2016). Thyroid stimulating hormone is a hormone, which is glycoprotein in nature, produced by the thyrotrophs cells present in the anterior pituitary. It plays a crucial role in the development and hormone production of the thyroid (Chaker & Peeters, 2022). TSH is consist of common alpha subunit and a unique beta subunit which basically are heterodimeric cysteine-knot glycoproteins. The subunits give them characteristic of hormone specificity (Szkudlinski *et al.,* 2002). After the production of TSH it is released in the blood circulation in a regulating manner, which then binds to the thyroid cells and here it activates the thyroid cells to secrete the

thyroid hormones (Magner, 1990). Thyroid hormones are synthesized by the thyroid glands which are the main hormonal regulators in body which synchronizes transformations of thyroid hormone across the diverse tissues in body during the post embryonic development stage and also regulates the homeostasis of metabolism and expenditure of energy (Zwahlen *et al.,* 2024). The hormones released by the thyroid gland are the thyroxine (T4) and triiodothyronine (T3) (Al-Suhaimi & Khan, 2022). T4 is mostly an inactive form and serves as reservoir in the thyroid gland while it is converted into the T3 which is active form and bind more strongly to the receptors of the thyroid hormones. Although T3 is active form it represents the 20% of the thyroid released hormone while T4 made up the total 80% of it. Through the process of de-iodination T4 is converted into T3 (Pirahanchi *et al.,* 2018). Thyroid stimulating hormone (TSH) and thyrotopin releasing hormone (TRH) are regulated, such as conversion in the negative feedback loop by circulating T4 and T3 stimulated by the hypothalamus (Brent, 1996).

There are mainly two disorders known as Hyperthyroidism and Hypothyroidism. Hyperthyroidism means excess thyroid hormone presence in body characterized by more expenditure of resting energy, loss of weight, reduced level of cholesterol, increase in process of lipolysis and gluconeogenesis, while Hypothyroidism means low thyroid hormone presence characterized by less expenditure of resting energy, gain of weight, increased level of cholesterol and reduction in process of lipolysis and gluconeogenesis (Mullur *et al.,* 2014). Hyperthyroidism is defined as the increase in level of the triiodothyronine (T3) and reduced level of the thyrotropin (T4) which is also known as thyroid stimulating hormone, and the main cause of the occurrence of it is Grave's disease (Lee & Pearce, 2023). Beside it, there are other factors that can lead to hyperthyroidism, both thyroid and the non-thyroid origin, such as hyperplasia, thyroid epithelium's over activation, damaged thyroid follicles and follicular epithelium characterized by acute destruction by different forms of metastatic tumors or thyroiditis and in addition, many different types of antineoplastic agents or drugs (LiVolsi & Baloch, 2018). The most common cause of hyperthyroidism is the graves' disease which mainly effect the thyroid gland and can effect humans at any age but is mostly seen in woman at the reproductive age (Davies *et al.,* 2020). Graves' disease is characterized by the decreased tolerance of immune against the antigens of thyroid while at the clinical characterization of it involves the thyrotoxicosis and also by presence of the serum anti-thyroid antibodies and of auto-reactive lymphocytes in the thyroid gland (Antonelli *et al.,* 2020). Hypothyroidism is defined as a condition in which the thyroid gland does not produces sufficient amount of thyroid hormones to meet the requirement of the peripheral tissue, while the main cause beside it, is Hashimoto thyroiditis (McDermott, 2020). Beside it, Primary hypothyroidism can be due to the deficiency of iodine, defects in enzymes, surgery of thyroid, thyroid irradiation after the graves' disease e.t.c while secondary hypothyroidism can be caused by the uncommon reasons such as hypothalamic or pituitary neoplasms, congenital hypopituitarism, radiation of external pituitary, tuberculosis, pituitary necrosis, and autoimmune mechanisms (Bereda, 2023). The systemic manifestations occurring because of the thyroid gland damage, usually develop primary hypothyroidism which characterize the Hashimoto's disease , mainly diagnosed on clinical characteristics such as lymphocytic infiltration on the cytological examination and positive result against thyroid antigens by serum antibodies (Weetman, 2021). The common symptoms associated with it are the gain of weight, constipation, dryness of skin, fatigue and lethargy (Yuan *et al.,* 2023).

Thyroid hormones play important role in the body but in failure of developing of brain to respond to the TSH can lead to the thyroid dysfunction in adults that can be linked to the psychiatric and cognitive problems. The common manifestation for the hyperthyroidism may include the agitation, apathy, psychosis and for hypothyroidism it may include the dysphoria, depression, cognitive decline specially in the more aged people (Jurado-Flores *et al.,* 2022). For the testing of the thyroid function, thyrotropin is usually taken as the starting point as it shows a remarkable response to change in peripheral thyroid hormone levels, therefore providing with the high level of detection of sensitivity. T3 and T4 are also measured alongside sometime as they are free hormones and they also help in assessing the severity of disease and possible outcomes for treatment can be carried out (Grebe & clinician, 2019). For the diagnosis of hyperthyroidism, biochemical tests must be carried out in which the blood is taken and examined, the low concentration of the TSH in it confirms it while alongside the high free T4 or high free T3 also adds confirmation in presence of disease. After the confirmation of the hyperthyroidism, nosological diagnosis must be carried out to find the reason behind the hyperthyroidism (Wiersinga *et al.,* 2023).The presence of high level of TSH confirms the hypothyroidism which is exceeded from the normal range of hormone level presence in body. Beside the high level TSH , the low level of free T4 further aids the confirmation in diagnosis (Wilson *et al.,* 2021).

For the treatment of thyroid disorders one should see the individual, patient centered choice for treatment, taking the consideration of different underlying factors of a person such as age, sex, pathology, preference of the patient and the availability of the surgical care expert. For instance the long term management for the hyperthyroidism patients should require a careful consideration of the all outcomes that can appear after treatment even the risk associated with hypothyroidism (Hughes & Eastman, 2021).

2. OBJECTIVES

Main and important purpose for conducting this research is: (1) To study the prevalence of the thyroid dysfunction and disorders which effect the normal functioning of the body. (2) To investigate the division of the disorders whether they are hyperthyroid or hypothyroid. (3) To check the prevalence within genders. (4) Investigating the age range and gender in which the disorders are more prominent. (5) Comparison based on age, gender and prevalence.

3. MATERIALS AND METHODS

An Analytical Study was carried out on the thyroid disorder, specifically identifying the hyperthyroidism and hypothyroidism condition by using thyroid stimulating hormone as a molecular marker for identification. It was based on the age and gender wise identification of condition and occurrence, in the region of Bahawalpur, Pakistan.

3.1. Sample collection

The random reports of thyroid stimulating hormone (TSH) of 210 patients were collected from the Al-Khidmat Laboratory, Bahawalpur Branch. The reports that were collected dated from the month of February 2025 to mid of May. It covered the region of Bahawalpur both rural and urban.

3.2. Inclusion criteria

It included both the genders, woman as well as man. The age range included the patients from 11 to 80 years. Reports were randomly selected without any prior screening.

3.3. Exclusion criteria

Only the reports about the TSH were collected. Sometimes T3 and T4 screening test are done with TSH which gives a complete picture of the thyroid function. TSH shows that how pituitary gland is signaling the thyroid to release the amount of hormone while T3 and T4 tells the exact amount of thyroid in blood. TSH alone are enough to tell the thyroid conditions and is reliable.

3.4. Diagnostic criteria for disease

The diagnostic criteria that was selected was from the AL-Khidmat lab normal standard range.

- TSH 0.25 – 5.00 µU/ML = NORMAL
- TSH <0.25 µIU/ML = hyperthyroidism
- TSH >5.00 µIU/ML = hypothyroidism

3.5. Statistical analysis

The statistical analysis was performed by using Microsoft Excel 2016. Patients were characterized into age groups and gender. Descriptive statics such as mean, median, mode and standard deviation were calculated. Graphical representations were used to visualize the data.

3.6. Ethical consideration

The data collected of patients were anonymized, and the privacy of each individual was maintained. The consent of the administration of the laboratory was taken to use the data for research purpose only. Throughout the study, all the ethical norms and required regulations were strictly followed.

3.7. Limitation

The data collected was only restricted to the region of Bahawalpur. Only the random 210 samples collected of almost 3 months. Due to the limited coverage of geography and very small size of sample, the findings may not represent the overall prevalence of thyroid disorders in general population.

4. RESULTS

4.1. Gender Wise Analysis of Thyroid-Stimulating Hormone (TSH) Data

In 210 reports, the total number of females was 168 which make the total of 80% while the total number of males was 42 which make the 20% of total patients. This shows that the female constitutes a greater number of thyroid complications as compared to the male.

4.1.1 Descriptive Analysis of Both Gender

The mean, median, mode, Standard Deviation (SD) and the observed minimum and maximum values of both genders were observed as follows.

Table 4.1. Descriptive statistics of thyroid stimulating hormone (TSH) levels among male and female patients (n=210). The > and < signs in minimum and maximum value indicate an automatic machine setting which detects the concentration of TSH to a given extent, the level of TSH exceeding from that range appears to be greater and lesser

Analysis	Female N=168	Male N=42	Total N=210
MEAN	5.50	8.22	6.04
MEDIAN	2.00	1.89	1.95
MODE	<0.05	>60.00	<0.05
STANDARD DEVIATION	±10.76	±16.93	±12.25
MINIMUM VALUE	<0.05	<0.05	<0.05
MAXIMUM VALUE	>60.00	>60.0	>60.00

4.2 Distribution of Thyroid Disorders by Age and Gender

4.2.1 Thyroid Disorder in Females

The total number of females were 168 out of 210, whose age ranged from minimum of 12 years and maximum of 80 years. They compromised almost 80% of the results. Some age female was missing as the results were randomly selected.

We found that from 168 females, 127 had positive results and were not found to have link to any of the thyroid disorder. The percentage came out to be 75.60%. Beside the normal the abnormal patients were 41 compromising 24.40%. The occurrence of hyperthyroidism from 41 patients was 13, which made 31.71% and for the hypothyroidism it was 28 out of 41, almost 68.29%. This made clear that the woman is more prone to hypothyroidism rather than the hypothyroidism.

This analysis shows that the range of age for most occurring of hyperthyroidism disease is between 51-60, followed by the age 31-40 respectively. For the hypothyroidism most the percentage showed by the both age range of 21-30 and 31-40, combined to age range of 21-40 respectively as shown in table 4.2.

Table 4.2. Distribution of thyroid stimulating hormone (TSH) levels among 168 Female patients, stratified by age groups. The table includes the number and percentage of normal and abnormal cases, along with further classification into hyperthyroidism and hypothyroidism

Age	Total Patient	Normal	Hyperthyroid	Hypothyroid
11-20	14	11	1	2
21-30	49	38	2	9
31-40	44	32	3	9
41-50	31	25	2	4
51-60	20	15	4	1
61-70	8	4	1	3
71-80	2	2	0	0

These results interpret that the woman are prone to develop the condition of hypothyroidism rather than the hyperthyroidism. We can also conclude that from this analysis that the age doesn't have any significant effect visible on the development of the thyroid disorder.

4.3 Thyroid disorders in males

The total number of males were 42 out of 210, whose age ranged from minimum of 11 years and maximum of 75 years. They compromised almost 20% of the results. Some age male was missing as the results were randomly selected.

We found that from 42 males, 31 had positive results and were not found to have link to any of the thyroid disorder. The percentage came out to be 73.81%. Beside the normal the abnormal patients were 11 compromising 26.19%. The occurrence of hyperthyroidism from 11 patients was 4, which made 36.36% and for the hypothyroidism it was 7 out of 11, almost 63.64%. This made clear that the man is more prone to hypothyroidism rather than the hypothyroidism.

This analysis shows that the range of age for most occurring of hyperthyroidism disease is between 41-50 respectively. For the hypothyroidism most the percentage showed by 51-60 and followed by 41-50 respectively. These results interpret that the man are prone to develop the condition of hypothyroidism rather than the hyperthyroidism. We can also conclude that from this analysis that the age doesn't have any significant effect visible on the development of the thyroid disorders as shown in table 4.3.

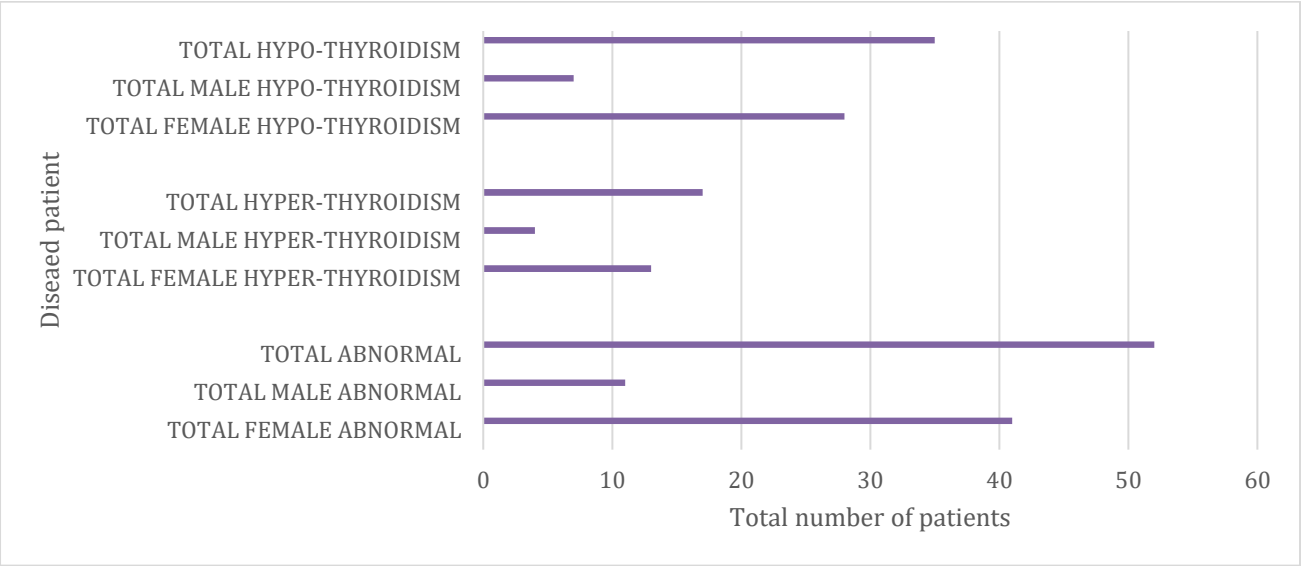
Table 4.3. Distribution of thyroid stimulating hormone (TSH) levels among 42 Male patients, stratified by age groups. The table includes the number and percentage of normal and abnormal cases, along with further classification into hyperthyroidism and hypothyroidism.

Age	Total Patient	Normal	Hyperthyroid	Hypothyroid
11-20	7	7	0	0
21-30	6	5	0	1
31-40	4	3	0	1
41-50	8	3	3	2
51-60	9	6	0	3
61-70	7	6	1	0
71-80	1	1	0	0

4.4 Comparison of Hyperthyroidism and Hypothyroidism Condition in Female and Male

The total occurrence of the hyperthyroidism in women was 76.47 % while men compromised the 23.53 %. For the hypothyroidism women compromised the 80 % while the men were 20%.

This comparison concluded that the both hyperthyroidism and hypothyroidism of disorder of thyroid were greater in women than men.



5. DISCUSSION

The Thyroid gland is one of the important glands in humans that secretes the hormones T3 and T4 controlled by the thyroid-stimulating hormone from pituitary gland. If the normal functioning of thyroid gland is disturbed it can cause many serious issues associated with thyroid disorders.an elevated TSH level typically indicates hypothyroidism while a suppressed TSH level indicates hyperthyroidism. These conditions should be treated as they can contribute to arising of other diseases such as graves' disease or Hashimoto's thyroiditis.

This study was conducted to check the prevalence and presence of thyroid disorders specially the hyperthyroidism and hypothyroidism conditions, which can be further diagnosed by special approaches to know what type of disease can arise by thyroid disorders or dysfunctions. In our study we found females are more likely to get thyroid disorders similar to (Mammen & Cappola, 2021) who also concluded that the thyroid dysfunction in woman are more prevalent than men. The high prevalence in females might be due to the sex differences in function of immune system.

Different results from (Zahedi *et al.,* 2020) found that the risk of thyroid cancer occur more in male than female and the these results differ from us. (Sharma *et al.,* 2021) clarified that thyroid dysfunction occur more in female rather than male.

It was found in our study that age does not have significance effect on thyroid conditions and is negative to it but (Khan & Ahmed, 2021) found increasing age worsen hypothyroidism but hyperthyroidism has negative effect against it.

A report showed that the women are exposed to the thyroid disorders rather than men as the difference may come from the gender accounted for autoimmune nature of the disorders of thyroid supporting the results we concluded (Mulder, 1998).

The man are less likely to develop the thyroid disorder and woman get more specially in pregnancy as it lower the TSH-reference and the thyroid function must be monitored throughout as the complications can lead to the maternal or fetus diseases (Gessl *et al.,* 2012) thus the report supported;(Vanderpump, 2019) thyroid disorder, hypothyroidism was more common in the older woman and ten times more common in the woman then in man while hyperthyroidism was greater than in woman instead of man. As compared to our study the gender was comparison was in favor but the age was comparison was here increased in older woman but on ours it was not constant but random.

6. CONCLUSION

The result and over all discussion concluded the prevalence of the thyroid disorders special the occurrence of hyperthyroidism and hypothyroidism in the region of Bahawalpur. From the results we came to the point that the thyroid disorders and dysfunction can cause serious issues that should be addressed. Compared to men, women are on higher chances to develop the disease of hyperthyroidism and hypothyroidism. The

total occurrence of hypothyroidism in women was 80% and for hyperthyroidism it was 76.47% while the men had 20% and 23.53% respectively. The study was conducted based on random reports of 210 persons out of which 168 females and 42 males. Only 52 were abnormal found compromising the 24.76%. This indicates that there is a significant increase in the thyroid disorders which should be controlled. The women are on greater risk to develop both the disease but in both gender the hypothyroidism was surprisingly great at 67.31% but hyperthyroidism was at the 32.69 %. The gender wise comparison was significantly high in females than man. The age doesn't have proper effect as it increases but rather it was most prominent in the Middle Ages for both the genders. Even the teenage and old also have some extent of thyroid disorders. Older age doesn't prove the disorder presence of thyroid.

Contribution of authors:
Research concept, design and data collection: Usama

Writing article and literature search, Data analysis and interpretation: Muhammad Shahzaib Rasheed

Supervision and final approval: Azka Sabir

Critical review: Shams-ur-Rehman

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