

# Relationship Between Sodium, Chloride, And Potassium Levels and Thyroid Hormone Levels in Thyroid Patients from Iraq

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## Abstract

Serum samples from thirty patients with thyroiditis disease (hyperthyroidism and hypothyroidism) were collected from visits to the endocrinology departments of the Baghdad Teaching Hospital and the Oncology Teaching Hospital and were compared to twenty control samples from healthy people. The results helped researchers determine the causes of the two conditions by applying theoretical analyses of the thyroid gland, which included calculating the total hormone concentration in the thyroid gland. Thyroiditis was shown to occur more frequently in females than in males, and to peak amongst the ages of 20-40. T3, T4, and TSH levels were all shown to be significantly different between hypothyroid, hyperthyroid, and control patients (P0.005). Serum levels of potassium and sodium are within the normal range, whereas chloride is slightly higher.

**Keywords:** *Electrolytes, Thyroid gland, TSH, Serum Level, Thyroiditis.*

## 1. Introduction

Tri-iodothyronine (T3) Thyroxin (T4) and reverse tri-iodothyronine (rT3) are the three primary iodothyronine hormones synthesized by thyroid follicle cells. In contrast to thyroxin and T3, recombinant T3 (rT3) has no influence on protein, carbohydrate, or lipid metabolism and has no effect on oxygen consumption [1]. Thyroid problems can be divided into two broad classes—hyperthyroidism and hypothyroidism—based on whether the patient's thyroid hormone levels are too high or too low [2].

Hyperthyroidism, also known as thyrotoxicosis, is a medical condition in which there is an abnormally high concentration of free thyroxine or free triiodothyronine in the blood. Around 2% of women and 0.2% of men are diagnosed with it each year. Most cases of Thyrotoxicosis are brought on by one of three conditions: Graves' disease, multinodular goiter, or independently functioning solitary thyroid nodules (7) The term "solvation" describes the process by which a salt is dissolved in a solvent like water, and the dissolved salt and solvent molecules dissociate into their constituent ions and atoms [3].

Mineral metabolism is also influenced by thyroid hormones. Changes in metal levels might cause additional symptoms for a patient with a thyroid disease. Mineral levels are routinely evaluated in all patients [4, 5]. Fast bone turnover, noteworthy phosphorus levels, and beneficial effects on parathormone and calcitonin all contribute to low Ca<sup>+</sup> levels, whereas high levels of Zn<sup>+</sup> and Mg<sup>2+</sup> reflect the effects on GFR and slower clearance of these minerals [6].

Both the internal fluid (ICF) and the extracellular fluid (ECF) contribute to the total body water. Because of its dependence on the Na/K-ATPase, the intracellular concentration of potassium (K<sup>+</sup>) is reduced when oxygen and energy levels are low. ECF has sodium (Na<sup>+</sup>) as its predominant ion. During development, ECF levels drop [7]. Newborns have a blood volume of 85–100 ml/kg of body weight, whereas adolescents and adults have a blood volume of 60–70 ml/kg of body weight [8].

Chloride (Cl<sup>-</sup>) is the most abundant anion in plasma, connective tissue, lymph, bone and cartilage, as well as the extracellular fluid. The proportion of exchangeable chloride to total body weight is very stable over the lifespan. Chloride intake and excretion typically mirror sodium intake and excretion, however external losses and excretion can occur separately, often maintaining a balance with bicarbonate status [5, 9]. Chloride is used and discarded frequently every day. Tubular reabsorption accounts for 60%-70% of the filtrated chloride, resulting in renal conservation. Serum T<sub>3</sub>, T<sub>4</sub>, TSH, Na, K, and Cl concentrations will be compared to those of healthy adults to determine the prevalence of thyroid disease [10, 11].

## **2. Materials and Methods**

### **2.1 Study groups**

The purpose of this research was to examine the metabolic alterations brought on by hyper and hypothyroidism. From August 2016 to October 2016, data were gathered from thirty individuals aged 20 to 70 who had been diagnosed with a thyroid problem at the endocrinology department of the Baghdad teaching hospital [12]. Patients with both overactive and underactive thyroids were included in this investigation. We obtained all of our samples from both the public and commercial labs at Baghdad City's Medical City. There were three distinct categories of patients:

- First, there was Group I, which included 16 people with hyperthyroidism (5 men and 11 women).
- Two men and twelve females with hypothyroidism made up Group II, which included a total of 14 patients.
- Three-person control group: - This group included 20 persons (9 males and 11 females) without signs of thyroid illness.

All patients are given a comprehensive Oncology examination, which includes a general medical history interview.

### **2.2 Collection of blood samples:**

Using a disposable syringe, 3 ml of venous blood was drawn and placed in a plain tube, then kept at room temperature (22°C) for 30 minutes to allow clot formation. Afterwards, the samples were centrifuged at 5000 rpm for 5 minutes to extract the serum, which was then placed in the freezer (-20°C) until it was time to analyze the T<sub>3</sub>, T<sub>4</sub>, TSH, K<sup>+</sup>, Ca<sup>2+</sup>, and Cl<sup>-</sup> levels [13].

### **2.3 Detection of Human TSH by ELISA, T<sub>3</sub>, and T<sub>4</sub>:**

In this assay, human TSH is measured using an antibody that has been coated onto a 96-well plate. The immobilized antibody recognizes TSH, and when a standard or sample is pipetted into the wells, the immobilized antibody binds to the TSH [14]. After the wells have been cleaned, anti-human TSH antibody that has been biotinylated is injected. Pipetting HRP-conjugated streptavidin into the wells

follows washing away any unbound biotinylated antibody. After another wash, a TMB substrate solution is introduced to the wells, and the quantity of TSH bound is seen by a change in color [15]. Blue light is converted to yellow by the Stop Solution, and its intensity is quantified as 450 nm.

#### **2.4 Determination of electrolyte level**

The two predominant analytical techniques employed in this field Flame Photometry is utilized for the determination of Na<sup>+</sup>, K<sup>+</sup>, and Cl<sup>-</sup> ions, although using an indirect measuring approach. Conversely, ISE methods enable direct measurements of these ions [16].

#### **2.5 The principle of the method**

The electrolyte analyzer employs the ion selective electrode approach to get accurate measurements during testing. Sodium, potassium, chlorine, calcium ions, lithium, and a CST electrode make up the experimental set-up's six electrodes. Separate electrodes is equipped with an ion-selective film that allows for the measurement of ion responses in matching samples [17]. The membrane functions as an ion exchanger, facilitating ionic charge reactions that result in changes in the membrane potential. This setup enables the detection of liquid, samples, and the membrane potential in between [18]. When both sides of the two electric potentials are checked, the resulting current is generated. The components involved in this process include the film, samples, reference electrode, liquid from the reference electrode, membrane, liquid in the internal electrodes, and the internal electrodes themselves.

The internal electrodes within the system are responsible for fluidizing and sampling the concentration difference of ions on both sides of the film electrode. This process generates an electrochemical voltage. The high voltage conductance of the internal electrodes facilitates the transmission of this voltage to the amplifier. Additionally, the reference electrode also contributes to the amplification process by guiding the voltage to its designated location. During the experiment, the concentration of the ion's standard solution was determined accurately to establish the calibration curve. Additionally, the concentration of the ions in the test sample was also measured [19].

#### **2.6 Statistical Analysis**

The SPSS was used to do the statistical analyses. Quantitative data are shown as median, mean standard deviation, and as numbers and percentages, whereas qualitative values are shown as counts and percentages. The Kruskal-Wallis test was employed to assess the disparities across groups, specifically focusing on individual group differences. The Chi-square test was employed to investigate the relationships between qualitative data. A p-value below 0.05 was deemed to be statistically significant.

### **3. Results**

#### **3.1 Demographical Picture of the Studied Samples**

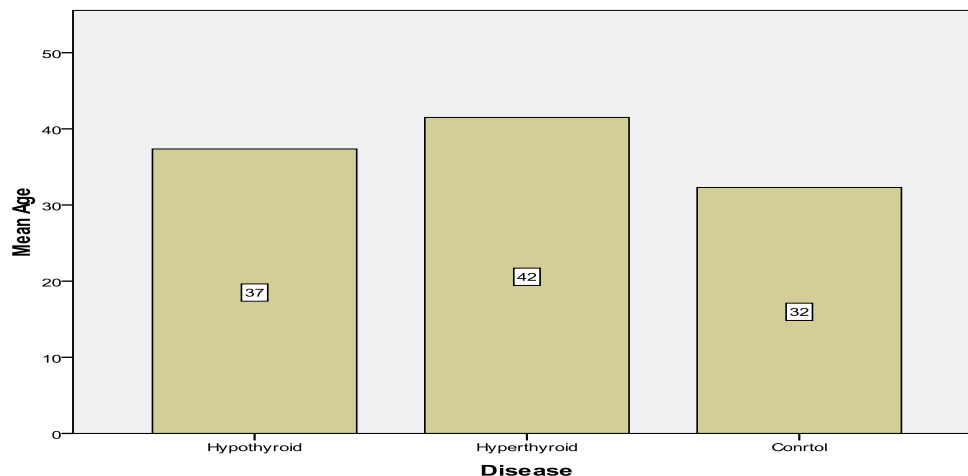
Patients with thyroiditis were separated into two groups, one consisting of those with hypothyroidism (14 people) and another with hyperthyroidism (16 people), based on the results of their medical histories and physical tests. Both hypothyroid and hyperthyroid patients followed the same demographic trends.

### 3.2 Clinical and Prevalence features of all studied groups

Thyroiditis prevalence across age groups and across sexes was analyzed using a clinical database. The majority of patients, both male (13%) and female (40%), were in their twenties and thirties. In this case, we can see this in (Table 1, Fig. 1). Additionally, it was observed that the female population constituted a significant majority of the patient sample, accounting for 76.7%, whilst the male population included a comparatively smaller proportion of 23.3%. There is no statistically significant difference in age, as shown by a p-value of 0.170.

**Table (1):** Age and sex distribution of patients with thyroiditis

Total Patients 30	Age (years.)			Total
	20-40	40-60	60-70	
<b>Male Patient</b>	<b>4</b>	<b>3</b>	<b>0</b>	<b>7</b>
%	(13.3)	(10)	(0)	(23.3)
<b>Female Patient</b>	<b>12</b>	<b>9</b>	<b>2</b>	<b>23</b>
%	(40)	(30)	(6.7)	(76.7)
<b>Total Patient</b>	<b>16</b>	<b>12</b>	<b>2</b>	<b>30</b>
%	(53.3)	(40)	(6.7)	(100)



**Figure. 1** presents a bar chart that illustrates the distribution of individuals among thyroiditis groups and the control group, categorized by age

### 3.3 The relationship between gender and disease distribution among individuals diagnosed with thyroiditis.

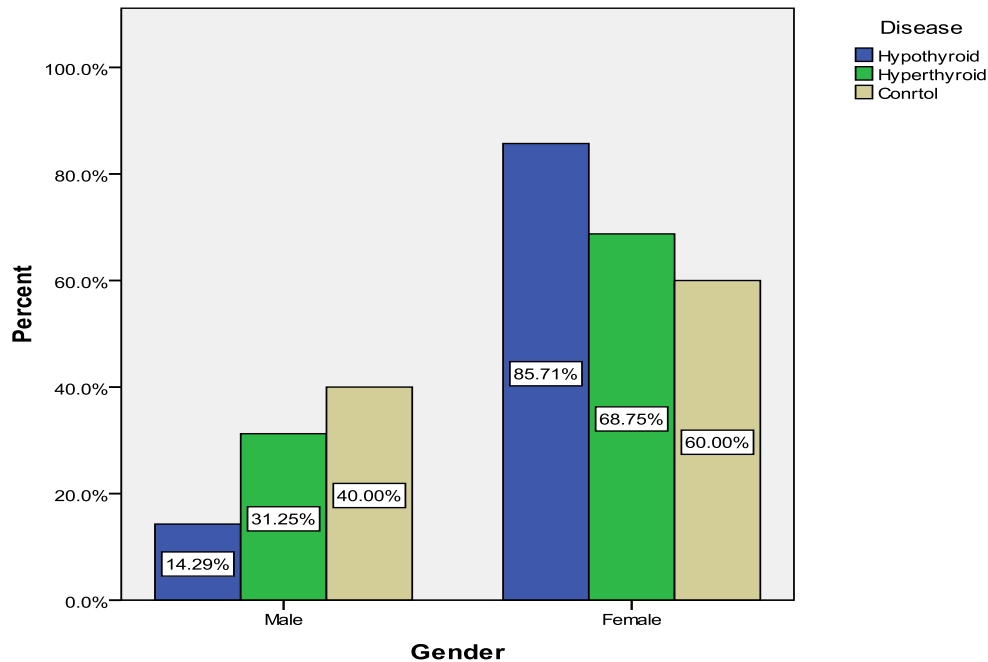
Seven men (23.4% of the total) had thyroiditis; two had hypothyroidism and five had hyperthyroidism (out of a total of 30 patients), whereas 23 women (76.7% of the total) had thyroiditis; twelve had hypothyroidism (85.7% of the total) and eleven had hyperthyroidism (68.8% of the total), as shown in Table (2).

**Table (2):** Gender and Disease distribution of patients with thyroiditis

	Gender		Total
	Male	Female	

Disease	Hypothyroid	Patients	2	12	14
		%	14%	85%	100%
	Hyperthyroid	Patients	5	11	16
		%	31%	68%	100%
	Control	Patients	8	12	20
		%	40%	60%	100%
Total		Patients	15	35	50
		%	30%	70%	100%

There is no significant relation ( $P = 0.271$ )



**Figure. 2:** A bar chart depicting the gender breakdown of illness prevalence

### 3.4 Thyroiditis patients' serum levels of T3, T4, and TSH were compared to those of healthy controls.

There are statistically significant differences ( $P < 0.005$ ) in T3, T4, and TSH levels between patients with hypothyroidism, hyperthyroidism, and healthy controls. Thyroiditis patients' serum T3, T4, and TSH values compared to healthy controls are shown in Table (4.3).

**Table 3:** Hypothyroid, hyperthyroid, and control patients all had significantly different levels of T3, T4, and TSH ( $P < 0.005$ ).

Disease	T3 ng/dL	T4 ng/dL	TSH uU/mL
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
<b>Hypothyroid</b>	5.66 $\pm$ 3.85	3.98 $\pm$ 3.132	23.76 $\pm$ 32.49
<b>Hyperthyroid</b>	2.12 $\pm$ 9.46	13.33 $\pm$ 3.285	3.02 $\pm$ 7.932
<b>Control</b>	1.00 $\pm$ 3.83	7.45 $\pm$ 1.616	1.71 $\pm$ 9.15

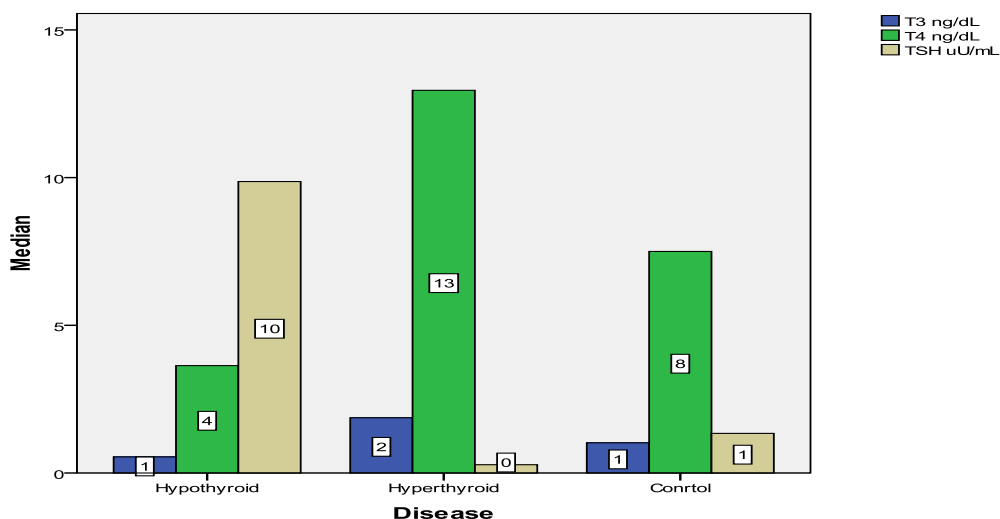


Figure. 3 is a bar chart depicting the prevalence of different groups with respect to serum T3, T4, and TSH levels.

Thyroiditis patients had substantially higher levels of serum chloride ( $P = 0.022$ ) compared to hypothyroid, hyperthyroid, and control patients, but no significant differences were found between the three groups for potassium ( $P = 0.069$ ) and sodium ( $P = 0.159$ ).

Table (4). Thyroiditis patients had lower serum potassium, sodium, and chloride levels than healthy controls.

Disease	Potassium mEq/L	Sodium mEq/l	Chloride mEq/l
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
“Hypothyroid”	4.18 $\pm$ 4.62	134.75 $\pm$ 5.157	105.31 $\pm$ 3.833
“Hyperthyroid”	3.92 $\pm$ 5.05	136.86 $\pm$ 3.968	104.12 $\pm$ 3.441
“Control”	3.85 $\pm$ 2.05	137.77 $\pm$ 2.251	103.41 $\pm$ 2.138

#### 4. Analysis and Discussion

Thyroiditis, defined largely by inflammation of the thyroid gland, comprises a broad spectrum of illnesses ranging from those marked by acute sickness with significant thyroid discomfort, such as sub-acute thyroiditis and infectious thyroiditis, to those characterized by chronic inflammation of the gland, such as Hashimoto's thyroiditis to those characterized primarily by thyroid dysfunction or goiter without any clinically obvious inflammation [10, 11].

Blood pressure, body temperature, and metabolic rate are all controlled by thyroid hormones. Renal hemodynamics, glomerular filtration, and electrolyte management can all be affected [12]. Thyroiditis often affects individuals above the age of 20, therefore our findings corroborate those of another study that found no statistically significant difference between the ages of patients diagnosed at 20 and 70 ( $P$  Value  $>0.05$ ) [14]. As previously reported [15] and by the American Thyroid Association in 2014 [16], this study found that 47.5% of the patients with thyroiditis were female and only 23.3% were male.

The findings of our study indicate a higher prevalence of Hypothyroidism in comparison to the control group. This suggests a potential role of anti-thyrotropin-receptor antibodies in the development

of hypothyroidism, maybe via the inhibition of thyrotropin function. The presence of these antibodies has been seen in 10% of those diagnosed with goitrous autoimmune thyroiditis and in 20% of those diagnosed with atrophic autoimmune thyroiditis [17,18]. The frequency at which anti-thyrotropin-receptor antibodies act as the only causative factor in cases of hypothyroidism remains uncertain.. About 5-10% of individuals with chronic autoimmune thyroiditis develop hypothyroidism due to thyrotropin-receptor-blocking antibodies, and only 40% of adults stay euthyroid once medication is stopped [19].

The prevalence of hyperthyroidism increases with age, which has been attributed to the recognized changes in thyroid gland structure and function that occur naturally with maturation [20]. Case studies in the medical literature suggest that electrolyte problems are common in individuals with hypo- or hyperthyroidism, however these cases often involve more extreme cases. Most patients in this research had normal TSH levels, and elevated or decreased TSH levels did not account for the presence of subclinical hypo- and hyperthyroidism, respectively.

This is the first large-scale investigation to our knowledge to investigate the effect of thyroid hormone on sodium and other electrolytes in the blood. To the contrary, new research presented in a letter did not reveal any link between elevated serum TSH and any adverse outcomes. Serum levels of Potassium and Sodium were found to be elevated, but not significantly ( $P>0.05$ ), whereas serum levels of Chloride were found to be somewhat elevated, but not significantly.

## Conclusion

There appears to be a link between thyroid function and electrolyte abnormalities, albeit this is likely only significant in extreme cases of hypo- or hyperthyroidism. In conclusion, the changes in serum electrolytes that we saw in individuals with thyroid effected patient were minor and not clinically significant. Note that severe thyroid dysfunctions such thyrotoxicosis or myxedema are the most likely causes of clinically significant electrolyte abnormalities. Furthermore, we demonstrate a higher prevalence of infection among females compared to males.

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