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RESEARCH ARTICLE

EVALUATION AND CORRELATION OF SERUM ELECTROLYTE PATTERN, MAGNESIUM, LDH AND VITAMIN D LEVELS IN PATIENTS OF HYPO THYROIDISM AT AT ERTIARY CARE CENTRE IN HARYANA

Isha Malik[1], Monica Verma[2], Ashuma Sachdeva[3] and Vasudha Dhupper[4]

1. Professor, Dept. of Biochemistry, Pt. BDS PGIMS, Rohtak.
2. Associate Professor, Dept. of Biochemistry, Pt. BDS PGIMS, Rohtak.
3. Professor, Dept. of Biochemistry, Pt. BDS PGIMS, Rohtak.
4. Assistant Professor, Dept. of Biochemistry, Pt. BDS PGIMS, Rohtak.

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Abstract

Introduction: Thyroid hormone is a central regulator of body hemodynamics, thermoregulation, and metabolic functions and in the disorders of the thyroid gland, signs and symptoms are often nonspecific. Both subclinical hypothyroidism and hyperthyroidism are associated with an increased risk of disease and alteration in biochemical and physiologic measures. In severe hypothyroidism and myxoedema, hyponatremia was a consequence of enhanced renal water retention mediated by vasopressin. Lactate dehydrogenase (LDH) is an enzyme found in nearly all living cells. It catalyzes the conversion of lactate to pyruvate and back, as it converts NAD^+ to NADH. However, only a few studies have investigated serum lactate dehydrogenase activity in patients with thyroid dysfunction. Vitamin D acts likea steroid hormone and is presently considered an immunomodulator affecting a wide range of functions.

Aim and Objectives: To estimate the levels of serum electrolytes like sodium, potassium magnesium, LDH, and vitamin D in hypothyroid patients and to correlate with TSH.

Materials and methods: The study population was serum specimens from 150 patients with hypothyroidism with ages ranging from 25-65 years. The samples were collected from the Thyroid laboratory, Department of Biochemistry, PGIMS, Rohtak. The different parameters of the study were estimated on the electrolyte analyzer, autoanalyzer, and radioimmunoassay.

Results and conclusion: The mean values for Na, K, Mg, LDH, and vitamin D were found to be 128.13±5.09, 3.01±0.25, 1.87±0.32, 604.89±175.79, and 7.48±1.61, respectively. Our findings support that hypothyroid patients have subtle disturbances of electrolytes, LDH and vitamin D levels.

Introduction:-

Thyroid hormones regulate and control the body's hemodynamics, thermoregulation, and metabolic functions. They also promote the growth of body tissues and sensitize them to the action of endogenous catecholamines. Thyroid

Corresponding Author:- Isha Malik
Address:- Professor, Dept. of Biochemistry, Pt. BDS PGIMS, Rohtak.

function disorders are considered the most common endocrine disorders affecting 5-10% of individuals. Clinical symptoms and signs are often nonspecific, and the diagnosis and monitoring of therapy depend crucially on measurements of thyroid hormones triiodothyronine (T_3) and thyroxine (T_4) along with thyroid-stimulating hormone (TSH) levels in the blood. The prevalence of thyroid disease increases with age, and hypothyroidism is the most typical thyroid disorder. Both subclinical hypothyroidism and hyperthyroidism are associated with an increase in the risk of disease and abnormalities in biochemical and physiological measures that are often abnormal in patients with overt thyroid disease.[1]

Only a few data on the association between thyroid function and electrolyte disorders have been found to exist. In many standard textbooks and reviews, different electrolyte disorders have been associated with thyroid dysfunction. As sodium and potassium are essential components of the enzyme Na-K ATPase, an enzyme on the cell membrane that helps transport water and nutrients across the cell membrane, the thyroid hormones regulate the activity of sodium-potassium pumps in most of the cell membrane the tissues.[2] In hypothyroidism, it may be because of low sodium levels and deficiency of thyroid hormones; this enzyme is affected, resulting in accumulation of water inside the cells and causing edema. This is said to be one of the mechanisms responsible for weight gain seen in hypothyroid patients.[3,4] Iwasaki et al. have shown that in severe hypothyroidism and myxoedema, hyponatremia was described to be a consequence of enhanced renal water retention mediated by vasopressin.[5] On the other hand, few studies have shown that hypokalemia, hypomagnesemia, and hypercalcemia may occur in patients with thyrotoxicosis.[6]

Magnesium is now identified as the most critical cation. It helps in the action of thyroid hormones and has countless other mechanisms in our body, catalyzing more than 300 biochemical reactions.[7] Magnesium is responsible for converting the inactive T4 thyroid hormone into the active form of T3. This is extremely important because the metabolism of the body cells is enhanced by T3, not inactive T4, hence magnesium and iodine deficiency are found to be related to goiter. Few studies have shown that a central biochemical event in thyroid disease is that of an acquired, altered mitochondrial function due to deficiency of both magnesium and selenium.[8]

Also as there is the recognition of a pattern of elevations of serum enzymes in hyperthyroid and hypothyroid patients and some studies have shown that LDH activity was increased and decreased in the hypo- and hyperthyroid states, respectively.[9]

Understanding of the role of vitamin D has been evolving since its discovery in the early 20th century, from being a simple vitamin to a steroid prohormone. It has been recognized to be involved in various immune functions and bone and muscle development.[10] Vitamin D deficiency is associated with autoimmune diseases, and it also plays an essential role in calcium homeostasis and the development and maintenance of the skeleton.[11] Vitamin D deficiency in adults is associated with cardiovascular disease, obesity, and lower High-Density Lipoprotein (HDL) levels. A severe vitamin D deficiency could be the cause of many diseases such as osteoporosis, cancers, diabetes, hypertension, obesity, Alzheimer's disease, heart disease, autoimmune thyroid diseases as well. Some studies have indicated that patients with hypothyroidism have vitamin D deficiency and that vitamin D improves thyroid function by Thyroid-stimulating hormone-TSH suppression in these patients.[12] Thyroid dysfunction has a significant impact on lipids and a number of other cardiovascular risk factors, and hypothyroidism is known as the cause of hyperlipidemia in both animals and humans. There is also the effect of vegetarian/non-vegetarian diet on the levels of vitamin D. [13]

The prevalence of vitamin D deficiency was found to be high in hypothyroid patients. Vitamin

D supplementation significantly decreased TSH levels but had no significant effect on T4 or

T3 concentrations. Hence it was suggested that there might be a relationship between vitamin D deficiency and hypothyroidism. Few other studies have reported that the prevalence of vitamin D insufficiency in Hashimoto's disease (92%) was significantly higher than in healthy controls (63%).[14]

With this background, the present study had been planned, which aimed at estimating the levels of serum electrolytes, LDH, and Vitamin D in patients with thyroid disorders, as limited data is available in this regard in the North Indian population.

Aim&Objectives:-

1. To estimate the levels of serum electrolytes, Magnesium, LDH, and Vitamin-D in patients with thyroid disorders and compare them with the healthy controls.
2. To study the correlation of TSH with serum electrolytes, Magnesium, LDH, and Vitamin-D in the cases.

Materialandmethods:-

The present study was conducted in the Department of Biochemistry Pt. B.D. Sharma PGIMS, Rohtak. The serum specimens received in the Thyroid laboratory from the institution's various departments constituted the study population. This study consisted of 150 patients with hypothyroidism in the age group of 25-65 years. The same number (150) of healthy age and sex-matched volunteers served as controls. Any lipemic or haemolysed samples were discarded. History was taken from the patients coming for thyroid hormone estimation in the sample collection area, and the information was collected on pretexted semi-structural proforma.

Inclusion criteria: The new patients provisionally diagnosed by the clinician as suffering from thyroid disease were enrolled in the study.

Exclusion criteria: Patients with any systemic disease, pregnant females, on any supplements or treatment were excluded from the study.

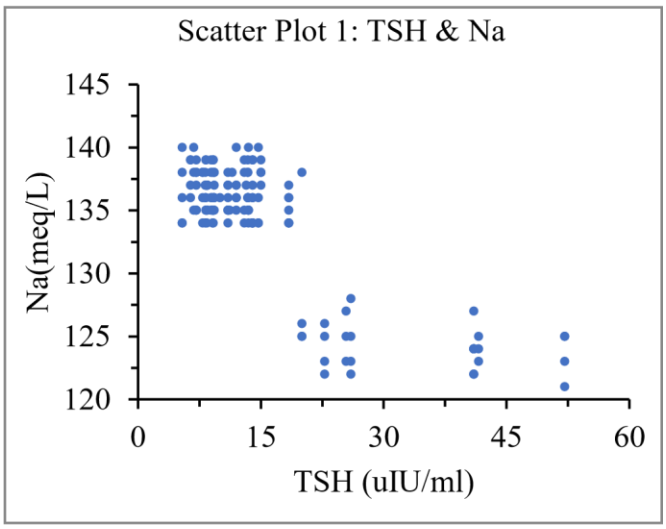
The serum electrolytes, sodium, and potassium were estimated by the electrolyte analyzer by the ion-selective electrode. In contrast, the concentrations of magnesium and LDH were determined on the Randox autoanalyzer by the kinetic methods. The concentrations of T3, T4, TSH, and vitamin D were estimated on SR 300 stratec by radioimmunoassay.

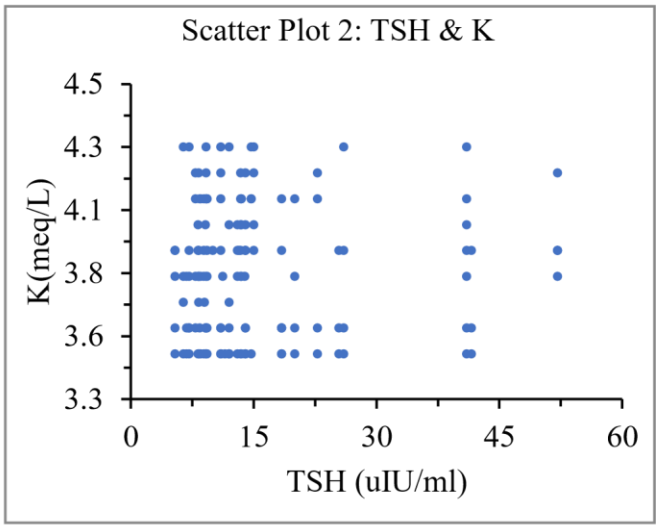
Results:-

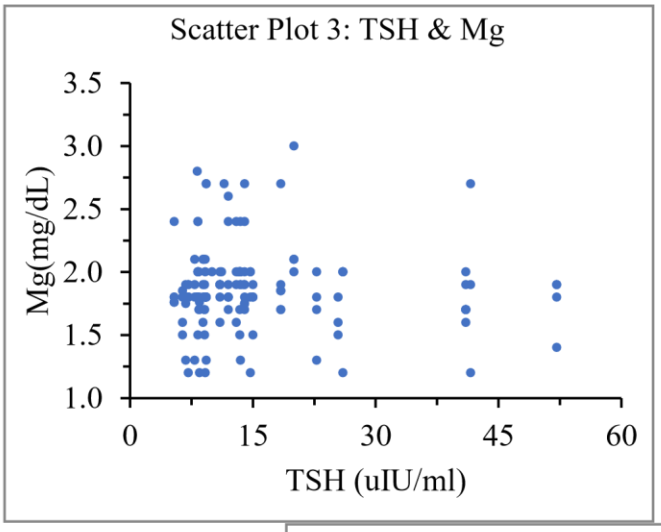
In the present study, the following results were observed. As shown in Table - I, the mean age was comparable in both groups. For the parameters like serum potassium and magnesium, the mean values were within their respective range both in cases and controls and statistically insignificant. For TSH and LDH, the mean values were found to be higher in cases, and there was a significant rise, whereas, for serum sodium and vitamin D, the mean values were significantly lowered in cases compared with the normal controls.

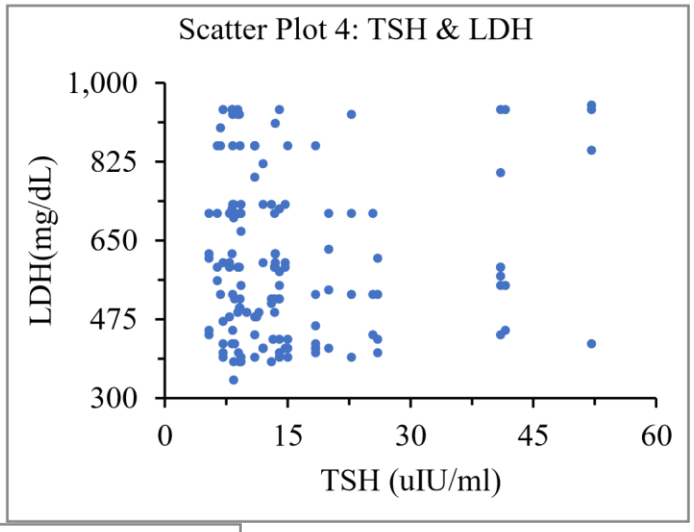
We also correlated TSH levels with serum sodium, potassium, magnesium, LDH, and Vitamin D using the Pearson's Correlation Coefficient. Serum sodium, potassium, magnesium, and vitamin D were found to be negatively correlated and while serum LDH was found to be positively correlated with TSH (Table-II).

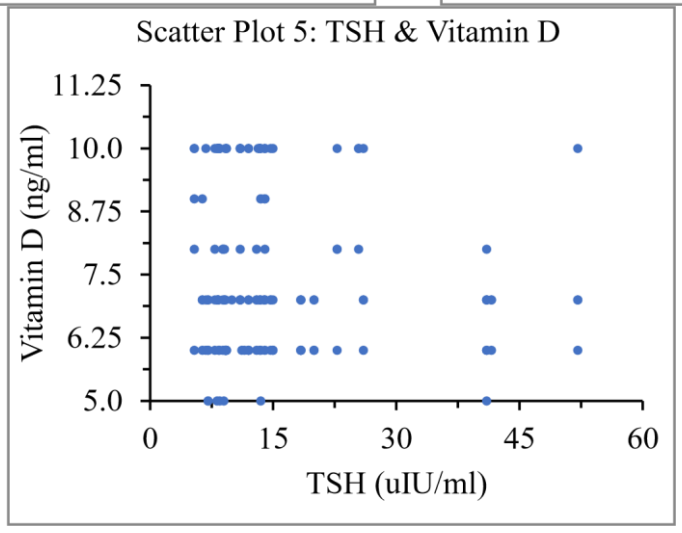
The scatter charts for the different parameters are plotted below.


Scatter Plot 1: TSH & Na
Na(meq/L)
145
140
135
130
125
120
0
15
30
45
60
TSH (uIU/ml)


Scatter Plot 2: TSH & K
K(meq/L)
4.5
4.3
4.1
3.8
3.6
3.3
0
15
30
45
60
TSH (uIU/ml)


Scatter Plot 3: TSH & Mg
Mg(mg/dL)
3.5
3.0
2.5
2.0
1.5
1.0
0
15
30
45
60
TSH (uIU/ml)


Scatter Plot 4: TSH & LDH
LDH(mg/dL)
1,000
825
650
475
300
0
15
30
45
60
TSH (uIU/ml)


Scatter Plot 5: TSH & Vitamin D
Vitamin D (ng/ml)
11.25
10.0
8.75
7.5
6.25
5.0
0
15
30
45
60
TSH (uIU/ml)

Discussion:-

Electrolytes play an essential role in many body processes, such as controlling fluid levels, acid-base balance (pH), nerve conduction, blood clotting, and muscle contraction. It has been found that thyroid hormones influence renal hemodynamics, glomerular filtration, and electrolyte handling as they regulate the activity of sodium-potassium pumps in most tissues. In our study, the serum sodium levels were decreased significantly in cases which may be explained by the fact that in hypothyroidism, there is a reduced capacity of free water excretion due to elevated antidiuretic hormone levels, which are mainly attributed to the hypothyroidisminduced decrease in cardiac output, increased peripheral resistance and reduced volume delivery to the kidneys resulting in a decline in glomerular filtration rate (GFR).[15]

Reduced GFR results in water retention and increases renal sodium excretion by decreasing sodium and net volume delivery to the distal diluting segment of the nephron. Hence fluid restriction is generally suggested for the management of such patients. However, recent data indicate that hypothyroidism-induced hyponatremia is relatively rare and probably occurs only in severe hypothyroidism.[16]

Since hypothyroidism can slow urinary potassium excretion, certain conditions that result in the release of potassium into the blood may result in hyperkalemia even if a person's kidneys are healthy. Horie et al. found that hyperkalemia develops in a small percentage of hypothyroid patients after thyroid hormone withdrawal. However, the serum potassium levels in our study were within the normal range.[17]

Regarding magnesium, studies have indicated no differences in the levels of urinary magnesium or creatinine levels in a patient with varying thyroid functionality. Furthermore, a previous study has shown that inhibiting mitochondrial oxidative phosphorylation may decrease thyroid cells' iodine uptake. Such uptake is achieved by a sodium iodide cotransporter requiring a mitochondrial energy supply dependent on magnesium.[18] But the mean magnesium levels were within the reference range and statistically insignificant in our study.

The elevated LDH levels in our study could probably be due to increased release or reduced clearance from the liver. LDH activity can be correlated with the degree of hypothyroidism, as there is significant involvement of skeletal muscle in hypothyroidism. Elevated CK and LDH enzymes are indicators of cellular necrosis and tissue damage. Hence Hypothyroidism should be considered in patients with myopathy and unexplained elevation of serum muscle enzymes. Therefore the measurement of muscle enzymes can be used for screening and early diagnosis of hypothyroidism in such patients.[19]

We observed a significant decrease in Vitamin D levels in patients suffering from hypothyroidism. This observation was in line with the previous studies. It was also found that the patients with hypothyroidism suffered from hypovitaminosis D. There was a significant negative correlation with TSH levels, which suggested that the deficiency of serum levels of vitamin D was significantly associated with the degree and severity of hypothyroidism. The low levels of vitamin D in these cases may be due to poor absorption of vitamin D from the intestine, or the body may not activate vitamin D properly.[20] It has also been known that both vitamin D and thyroid hormone bind to similar receptors called steroid hormone receptors. Some polymorphisms in the Vitamin D receptor (VDR) gene may predispose people to autoimmune thyroid disease, including Graves' disease and Hashimoto's thyroiditis. Some previous studies have demonstrated that vitamin D also modulates pituitary TSH secretion by binding to specific binding sites and hence associated with thyroid disorders.[21]

Further, Wang et al. found that vitamin D administration significantly suppressed TSH secretion in the basal state. He also showed that serum TSH levels of middle-aged and older women were higher than those of same-age men. This result may indicate that TSH secretion is regulated by sex hormones, genetic susceptibility, or environmental factors, mediating the relationship between vitamin D status and serum TSH level. In addition, another study found that circulating estrogen could induce serum TSH suppression in males by acting on the pituitary, and vitamin D has been shown to have an essential role in estrogen synthesis of both female and male gonads as it also acts as a steroid hormone.[22]

Conclusion:-

Our findings support that thyroid disorders are usually associated with subtle disturbances in electrolytes and LDH levels, and these parameters should be routinely measured during the treatment and monitoring of hypothyroid

patients. As thyroid hormones affect many metabolic processes, the above measurement may affect the final outcome. It may be concluded that early detection of any abnormality in the parameters mentioned above can prevent further complications related to the disorder and will be helpful during the management of any thyroid disorder.

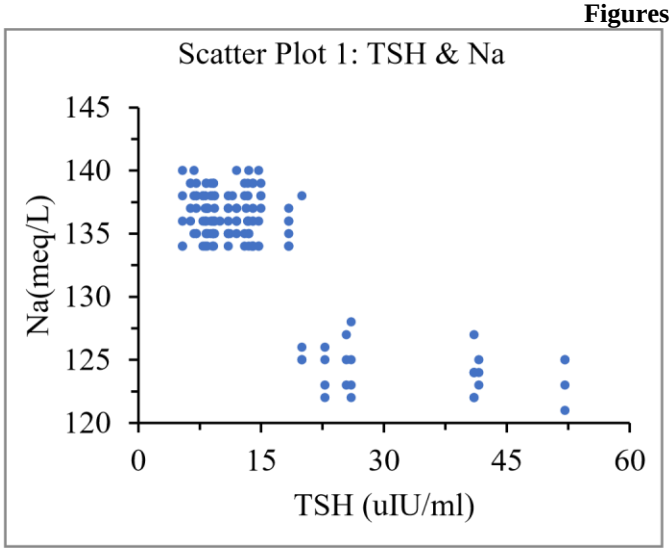
Table-I:-

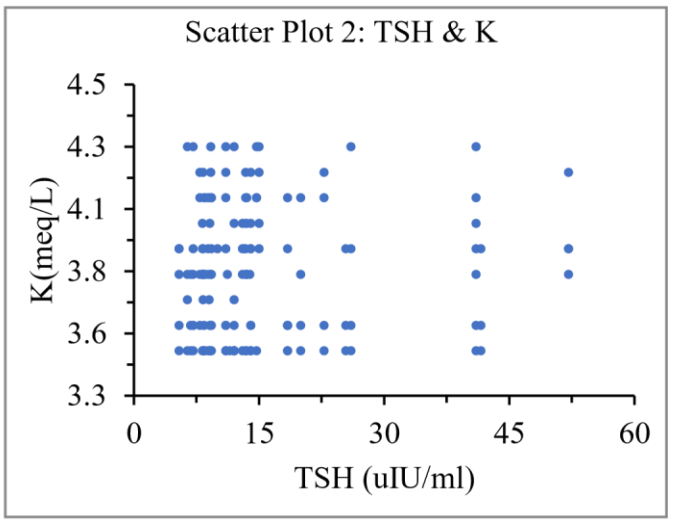
Parameter	Controls (Mean±SD)	Hypothyroid patients (Mean±SD)	p value
Age(years)	36.62±9.48	38.1±11.30	>0.05
TSH (µIU/mL)	2.83±0.39	15.21±10.69	<0.05
Sodium (meq/L)	136.42±1.76	128.13±5.09	< 0.05
Potassium (meq/L)	3.77±0.22	3.01±0.25	>0.05
Magnesium(mg/dL)	2.20±0.13	1.87±0.32	> 0.05
LDH (mg/dL)	317.45±43.13	604.89±175.79	<0.05
Vitamin D(ng/mL)	11.66±1.64	7.48±1.61	< 0.05

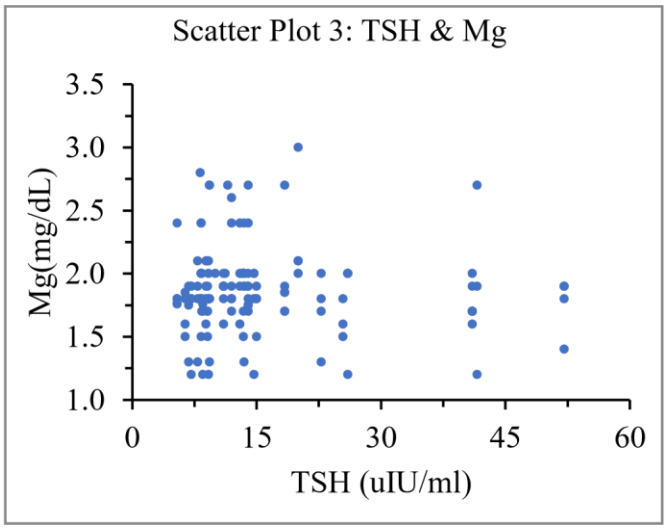
Table II:-

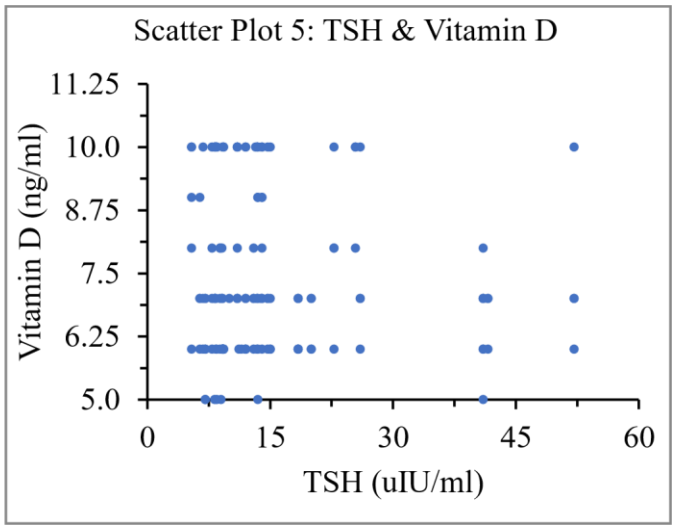
TSH		Sodium	Potassium	Magnesium	LDH	Vitamin D
Correlation Coefficient value)	(r	-0.05	-0.016	-0.051	0.092	-0.006

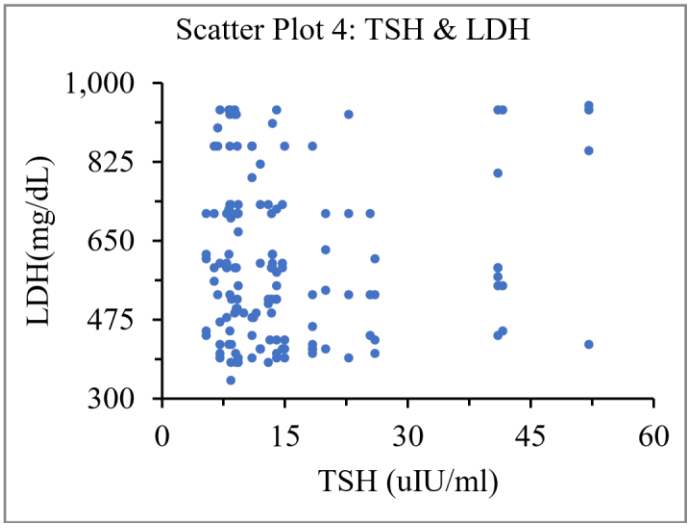
Figures











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