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The Relationship between Thyroid Hormones and Hematological Parameters in Patients with Hyperthyroidism

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ABSTRACT
Hyperthyroidism is a condition characterized by increased production and secretion of thyroid hormones by the thyroid gland, commonly caused by Graves' disease and toxic multinodular goiter. Thyroid hormones play a crucial role in various physiological processes, including hematopoiesis in the bone marrow. Several studies have shown that thyroid hormones can directly and indirectly influence hematological parameters, potentially leading to anemia in patients. This study aimed to determine the relationship between T3, T4, fT3, fT4, and TSH hormones with hematological parameters in hyperthyroid patients. Data was obtained from 83 hyperthyroid patients at Dr. Cipto Mangunkusumo National General Hospital, Jakarta. Analysis used multiple linear regression and the chi-square test. The results showed a significant relationship between FT3 and MCHC, as well as between TSH, T3, T4, and FT4 with several hematological parameters, such as hemoglobin, hematocrit, erythrocytes, platelets, and MCV. However, no significant relationship was found with leukocyte count and MCH values.
Keyword: Thyroid, MCV, Hematology, Hyperthyroidism

ABSTRAK
Hipertiroid merupakan kondisi peningkatan produksi dan sekresi hormon tiroid oleh kelenjar tiroid, yang umumnya disebabkan oleh penyakit Graves dan goiter multinodular toksik. Hormon tiroid berperan penting dalam berbagai proses fisiologis, termasuk hematopoiesis di sumsum tulang. Beberapa penelitian menunjukkan bahwa hormon tiroid dapat memengaruhi parameter hematologi secara langsung maupun tidak langsung sehingga berpotensi menyebabkan anemia pada pasien. Penelitian ini bertujuan mengetahui hubungan hormon T3, T4, fT3, fT4, dan TSH dengan parameter hematologi pada pasien hipertiroid. Data diperoleh dari 83 pasien hipertiroid di RSUP Nasional Dr. Cipto Mangunkusumo Jakarta. Analisis menggunakan regresi linier berganda dan uji chi-kuadrat. Hasil menunjukkan hubungan bermakna antara FT3 dengan MCHC serta hubungan TSH, T3, T4, dan FT4 dengan beberapa parameter hematologi seperti hemoglobin, hematokrit, eritrosit, trombosit, dan MCV. Namun, tidak ditemukan hubungan bermakna dengan jumlah leukosit dan nilai MCH.
Keyword: Tiroid, MCV, Hematologi, Hipertiroid

1. Introduction

Hyperthyroidism is a condition characterized by increased production and secretion of thyroid hormones by the thyroid gland. The main causes of hyperthyroidism include Graves' disease and toxic multinodular goiter [1]. Thyroid hormones play a crucial role in regulating various metabolic processes, including hematopoiesis within the bone marrow [2]. Consequently, hyperthyroidism may result in a wide range of clinical manifestations affecting multiple organ systems.

Thyroid hormones are known to influence hematopoiesis by increasing metabolic activity and tissue oxygen demand [3]. Excess thyroid hormone activity may alter the production of erythrocytes, leukocytes, and platelets. These alterations may be reflected in hematological parameters, including hemoglobin, hematocrit, erythrocyte count, and erythrocyte indices such as MCV, MCH, and MCHC

[4]. Therefore, alterations in thyroid hormone levels may contribute to variations in hematological parameters.

Several studies have demonstrated that thyroid dysfunction is associated with hematological abnormalities, including mild anemia and alterations in erythrocyte indices [5]. However, the association between thyroid hormone levels and hematological parameters in patients with hyperthyroidism remains insufficiently investigated, particularly in the Indonesian population. A better understanding of this relationship may provide valuable insights into the systemic effects of thyroid dysfunction.

Despite previous studies reporting hematological alterations in patients with thyroid dysfunction, evidence regarding the association between thyroid hormone levels and hematological parameters in Indonesian patients with hyperthyroidism remains limited. Therefore, this study aimed to determine the association between thyroid hormone levels and hematological parameters among patients with hyperthyroidism at Dr. Cipto Mangunkusumo National Central General Hospital, Jakarta. The findings of this study are expected to contribute to a better understanding of the relationship between thyroid function and hematological parameters in patients with hyperthyroidism, thereby supporting improved clinical evaluation and patient management.

2. Methods

2.1 Research Design

This study employed an analytical observational cross-sectional design using secondary data obtained from patients' medical records. The study aimed to determine the association between thyroid hormone levels and hematological parameters in patients with hyperthyroidism.

2.2 Research Location and Time

This study was conducted using medical records of patients treated at Dr. Cipto Mangunkusumo National Central General Hospital, Jakarta. The medical records included in this study covered the period from 2013 to 2015.

2.3 Population and Sample

The population in this study consisted of patients diagnosed with hyperthyroidism who underwent laboratory examinations at Dr. Cipto Mangunkusumo National Central General Hospital, Jakarta. The sample in this study included 83 patients who met the inclusion criteria. Eligible medical records were selected based on the predefined inclusion criteria. Only patients with complete laboratory examination results were included in the analysis. [6].

2.4 Research Variables

The independent variables in this study were thyroid hormone levels, including triiodothyronine (T3), thyroxine (T4), free triiodothyronine (fT3), free thyroxine (fT4), and thyroid-stimulating hormone (TSH). The dependent variables were hematological parameters, including hemoglobin, hematocrit, erythrocyte count, leukocyte count, platelet count, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) [7].

2.5 Data Collection Procedure

Data were collected retrospectively from patients' medical records at Dr. Cipto Mangunkusumo National Central General Hospital. Information regarding thyroid hormone levels (T3, T4, fT3, fT4, and TSH) and hematological parameters (hemoglobin, hematocrit, erythrocyte count, leukocyte count, platelet count, MCV, MCH, and MCHC) was obtained from laboratory examination results recorded in the medical records. Only medical records that fulfilled the inclusion criteria and contained complete laboratory data were included in the analysis.

2.6 Data Analysis

Statistical analysis was performed using IBM SPSS Statistics version 22 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the demographic characteristics, thyroid hormone levels, and hematological parameters of the study participants. Multiple linear regression analysis was performed to assess the associations between thyroid hormone levels (TSH,

T3, T4, FT3, and FT4) as independent variables and hematological parameters (hemoglobin, hematocrit, erythrocyte count, leukocyte count, platelet count, MCV, MCH, and MCHC) as dependent variables. Chi-square analysis was also performed to evaluate the association between categorical thyroid hormone variables and categorical hematological variables. A p-value of <0.05 was considered statistically significant.

2.7 Ethical Considerations

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Indonesia/Dr. Cipto Mangunkusumo National Central General Hospital (Approval No. LB.02.01/X.2/238/2015). As this study used retrospective secondary data from medical records, patient confidentiality was maintained by anonymizing all personal identifiers.

3. Results and Discussion

3.1 Characteristics of Patients

A total of 83 patients diagnosed with hyperthyroidism were included in this study. The characteristics of the patients were analyzed based on age and sex distribution. The results showed that most patients with hyperthyroidism were female. Female patients accounted for the majority of cases compared with male patients. This finding is consistent with previous studies reporting that hyperthyroidism is more common in women due to hormonal and autoimmune factors [8]. The distribution of patients based on age and sex is presented in Table 1.

Table 1. Characteristics of Hyperthyroid Patients Based on Age and Sex

Sex	Age (Years)		Total
	<30	>30	
Male	3	10	13
	3.6%	12.0%	15.7%
Female	14	56	70
	16.9%	67.5%	84.3%
Total	17	66	83
	20.5%	79,5%	100%

Based on Table 1, most hyperthyroid patients were female, accounting for 70 patients (84.3%), while male patients accounted for only 13 patients (15.7%). In addition, the majority of patients were aged over 30 years, with 66 patients (79.5%), whereas patients under 30 years accounted for 17 patients (20.5%). These findings indicate that hyperthyroidism is more frequently observed in adult women, particularly those above 30 years of age.

This pattern is consistent with previous studies showing that autoimmune thyroid disorders, including Graves' disease, occur more frequently in women than in men. The higher prevalence in women is associated with hormonal influences, genetic susceptibility, and immune system differences between sexes [9]. In addition, the risk of thyroid dysfunction tends to increase with age, which may explain the higher number of patients in the age group above 30 years [10].

3.2 Thyroid Hormone Levels

Thyroid hormone levels were analyzed to determine the hormonal profile of patients with hyperthyroidism. The parameters measured in this study included triiodothyronine (T3), thyroxine (T4), free triiodothyronine (FT3), free thyroxine (FT4), and thyroid stimulating hormone (TSH). The results showed variations in thyroid hormone levels among patients. Elevated thyroid hormone levels are generally associated with increased metabolic activity due to excessive hormone production in hyperthyroidism [11]. The descriptive statistics of thyroid hormone levels are presented in Table 2.

Based on Table 2, most patients showed abnormal thyroid hormone levels, particularly increased FT3, FT4, T3, and T4 levels, while TSH levels were generally decreased. This pattern is characteristic of hyperthyroidism, in which excessive production of thyroid hormones leads to suppression of thyroid stimulating hormone through negative feedback mechanisms in the hypothalamic–pituitary–thyroid axis [12].

Table 2. Thyroid Hormone Levels in Hyperthyroid Patients

	Minimum	Maximum	Mean	SD	Normal	Abnormal
FT3 (pg/mL)	2.28	32.55	6.31	5.09	18	65
FT4 (ng/mL)	0.79	7.77	3.56	2.03	13	70
T3 (ng/mL)	0.87	7.96	3.61	1.65	12	71
T4 (µL/dL)	4.32	30.78	18.49	5.82	18	65
TSHs (µIU/mL)	0.01	5.01	0.23	0.81	7	76

Elevated thyroid hormone levels may lead to increased metabolic activity, oxygen consumption, and stimulation of various physiological processes in the body. Excess thyroid hormones can also affect several organ systems, including the cardiovascular, nervous, and hematopoietic systems [11], [13]. Therefore, evaluation of thyroid hormone levels is essential in understanding the systemic effects of hyperthyroidism and its potential association with changes in hematological parameters.

3.3 Hematological Profile

The hematological parameters analyzed in this study included hemoglobin, hematocrit, erythrocytes, leukocytes, platelets, and erythrocyte indices such as MCV, MCH, and MCHC. The results showed variations in hematological parameters among patients with hyperthyroidism. Thyroid hormones are known to influence hematopoiesis through metabolic stimulation and increased oxygen demand in tissues [2]. The hematological profile of patients with hyperthyroidism is presented in Table 3.

Table 3. Hematological Profile of Hyperthyroid Patients

	Male		Female	
	Mean	**SD**	**Mean**	**SD**
HB (g/dL)	9.62	2.56	9.99	1.91
Ht (%)	27.90	7.41	30.03	6.91
Eritrosit (10^6/µL)	4.18	0.83	4.28	0.62
MCV (FL)	80.47	5.08	78.28	6.99
MCH (Pg)	26.85	2.64	26.53	3.61
MCHC (g/dL)	32.35	2.20	32.35	4.04
	Mean		**SD**	
Leukosit	11.85		14.09	
Trombosit	247.92		83.35	

Based on Table 3, the mean hemoglobin and hematocrit levels in both male and female patients were relatively low compared to normal reference values, which may indicate the presence of mild anemia in patients with hyperthyroidism. Several studies have reported that thyroid hormone imbalance can affect erythropoiesis and iron metabolism, which may lead to decreased hemoglobin levels and hematocrit values in patients with thyroid disorders [14].

The erythrocyte indices, including MCV, MCH, and MCHC, observed in this study were generally within or close to the normal ranges. This finding suggests that most patients may present with normocytic or slightly microcytic erythrocyte characteristics. Thyroid hormones play an important role in the regulation of red blood cell production through their influence on metabolic activity and oxygen consumption in body tissues [15].

In addition to erythrocytes, thyroid dysfunction may also influence leukocyte and platelet production. Alterations in leukocyte count have been reported in patients with thyroid disorders due to immune system involvement and inflammatory responses associated with autoimmune thyroid disease [9]. Platelet counts in patients with hyperthyroidism are generally within normal limits, although some studies have reported mild variations related to metabolic and hormonal changes [14]. These findings indicate that hyperthyroidism may be associated with various hematological changes that reflect the systemic effects of thyroid hormone excess on the hematopoietic system.

3.4 Relationship between Thyroid Hormone and Hematological Parameters

To determine the relationship between thyroid hormone levels and hematological parameters, statistical analysis was performed using multiple linear regression and chi-square tests. The results showed a significant relationship between FT3 levels and MCHC values ($p < 0.05$). These findings suggest that alterations in FT3 levels may influence erythrocyte indices, particularly mean corpuscular hemoglobin concentration. Thyroid hormones are known to affect red blood cell metabolism and erythrocyte maturation, which may lead to variations in erythrocyte indices [13].

In addition, chi-square analysis revealed significant associations between TSH levels and hemoglobin, as well as between T3 and T4 levels and hematocrit values. These findings suggest that thyroid hormone imbalance may affect hematological profiles in patients with hyperthyroidism. The relationship between thyroid hormone levels and hematological parameters may be explained by the role of thyroid hormones in regulating metabolism and hematopoiesis. Increased thyroid hormone activity may stimulate erythropoietin production and influence red blood cell formation [2].

Several studies have also reported that excessive thyroid hormone levels may alter bone marrow activity and oxygen consumption in tissues, which can subsequently affect hemoglobin concentration and hematocrit levels in patients with thyroid disorders [3]. Therefore, evaluation of hematological parameters in patients with hyperthyroidism may provide important information regarding the systemic effects of thyroid hormone imbalance.

3.5 Discussion

The present study demonstrated significant associations between thyroid hormone levels and several hematological parameters among patients with hyperthyroidism. Significant relationships were identified between FT3 and MCHC, TSH and hemoglobin, as well as T3 and T4 with hematocrit. These findings indicate that thyroid hormone imbalance may influence erythropoiesis and selected hematological indices, supporting the important role of thyroid hormones in hematopoietic regulation and systemic metabolism [2], [13].

The significant association between FT3 and MCHC observed in this study suggests that thyroid hormone activity may affect erythrocyte indices [3], [4]. FT3 is the biologically active form of thyroid hormone and plays a central role in regulating cellular metabolism and oxygen utilization [13]. Increased metabolic activity induced by excessive thyroid hormone may stimulate erythropoietin production and enhance erythroid precursor proliferation in the bone marrow, thereby influencing hemoglobin synthesis and erythrocyte maturation [2], [13]. Similar findings have been reported by Yang et al. [2], who demonstrated that hyperthyroidism affects hematopoietic function through increased metabolic demand and bone marrow stimulation. Likewise, Ahmed and Mohammed [3], AL-Dewachi et al. [4], and Dorgalaleh et al. [16], eported significant alterations in erythrocyte indices among patients with thyroid dysfunction, supporting the close interaction between thyroid hormone status and red blood cell physiology.

A significant association was also identified between TSH levels and hemoglobin concentration. Thyroid hormones influence erythropoiesis both directly through stimulation of erythroid progenitor cells and indirectly by increasing erythropoietin secretion in response to elevated tissue oxygen demand [13]. Consequently, disturbances in thyroid hormone homeostasis may contribute to alterations in hemoglobin concentration. These findings are consistent with previous studies reporting hematological abnormalities, particularly changes in hemoglobin levels, among patients with thyroid dysfunction [3]. However, the strength of these associations has not been consistent across studies. Differences in patient characteristics, disease severity, nutritional status, iron availability, duration of thyroid dysfunction, and treatment status may partly explain these discrepancies [4].

The present study also demonstrated significant associations between T3 and T4 levels and hematocrit. Thyroid hormones are known to increase basal metabolic rate and oxygen consumption, leading to enhanced erythropoietic activity and changes in circulating red blood cell mass [13]. These physiological mechanisms may explain the observed relationship between thyroid hormone levels and hematocrit. Similar variability has also been reported by Ahmed and Mohammed [3] and Mandefro et al. [5], who found that patients with thyroid hormone dysfunction frequently exhibit

abnormalities in hemoglobin, hematocrit, and erythrocyte indices. Nevertheless, variations among published studies may reflect differences in sample size, ethnicity, iodine status, and the underlying etiology of hyperthyroidism, highlighting the complexity of hematological alterations associated with thyroid disorders [17].

Although significant associations were observed for selected hematological parameters, no significant relationships were found for several other hematological variables. Similar variability has also been reported by Ahmed and Mohammed [3] and Mandefro et al. [5], indicating that hematological manifestations of thyroid dysfunction are heterogeneous and may be influenced by disease severity, nutritional status, autoimmune activity, and treatment status. Individual physiological variation, concomitant diseases, and therapeutic interventions may further contribute to these inconsistent findings.

From a clinical perspective, the findings of the present study highlight the importance of routine hematological assessment in patients with hyperthyroidism. In addition to thyroid function tests, evaluation of hemoglobin, hematocrit, and erythrocyte indices may provide complementary information regarding the systemic effects of thyroid hormone excess. Early recognition of hematological abnormalities may facilitate comprehensive patient evaluation, improve treatment monitoring, and assist clinicians in preventing complications associated with prolonged thyroid hormone imbalance. Therefore, integrating hematological parameters into the routine assessment of patients with hyperthyroidism may enhance clinical decision-making and patient management.

Overall, the present study provides additional evidence that thyroid hormone imbalance is associated with alterations in selected hematological parameters. These findings contribute to the growing body of evidence regarding the interaction between thyroid function and hematopoiesis and support the need for future multicenter prospective studies to validate these associations and further elucidate the underlying biological mechanisms.

4. Conclusion

The present study demonstrated that thyroid hormone levels are associated with selected hematological parameters in patients with hyperthyroidism, highlighting the close relationship between thyroid function and hematopoietic regulation. These findings suggest that thyroid hormone imbalance is associated with alterations in hematological profiles and provide additional evidence regarding the systemic manifestations of hyperthyroidism.

From a clinical perspective, routine hematological assessment may serve as a useful complementary tool in the evaluation and monitoring of patients with hyperthyroidism. Further multicenter studies with larger sample sizes are warranted to validate these findings and to further elucidate the biological mechanisms underlying the observed associations.

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References

[1] R. S. Bahn *et al.*, “Hyperthyroidism and other causes of thyrotoxicosis: management guidelines of the American Thyroid Association and American Association of Clinical Endocrinologists,” *Thyroid*, vol. 21, no. 6, pp. 593–646, Jun. 2011, doi: 10.1089/thy.2010.0417.

[2] W. Yang *et al.*, “The impact of hyperthyroidism on the hematopoietic system,” *Clin. Exp. Med.*, vol. 26, no. 1, p. 85, Dec. 2025, doi: 10.1007/s10238-025-01999-z.

[3] S. S. Ahmed and A. A. Mohammed, “Effects of thyroid dysfunction on hematological parameters: Case controlled study,” *Ann. Med. Surg.*, vol. 57, pp. 52–55, Sep. 2020, doi: 10.1016/j.amsu.2020.07.008.

[4] S. O. AL-Dewachi, A. B. Al-Dewachi, and R. Y. Alhamdani, "Association between thyroid hormone levels and hematological indices among women with thyroid disorders," *Qatar Med. J.*, vol. 2025, no. 3, 2025, doi: 10.5339/qmj.2025.73.

[5] B. Mandefro, A. Kelem, Z. A. Gebreegziabher, Y. Gelaw, E. Shiferaw, and T. Adane, "Hematological abnormalities and associated factors among patients with thyroid hormone dysfunction at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia," *PLoS One*, vol. 20, no. 5, May 2025, doi: 10.1371/journal.pone.0322748.

[6] J. P. Vandenbroucke *et al.*, "Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration," *PLoS Med.*, vol. 4, no. 10, pp. 1628–1654, Oct. 2007, doi: 10.1371/journal.pmed.0040297.

[7] D. S. Ross *et al.*, "2016 American Thyroid Association Guidelines for Diagnosis and Management of Hyperthyroidism and Other Causes of Thyrotoxicosis," *Thyroid*, vol. 26, no. 10, pp. 1343–1421, Oct. 2016, doi: 10.1089/thy.2016.0229.

[8] P. N. Taylor *et al.*, "Global epidemiology of hyperthyroidism and hypothyroidism," *Nat. Rev. Endocrinol.*, vol. 14, no. 5, pp. 301–316, May 2018, doi: 10.1038/nrendo.2018.18.

[9] A. Antonelli, S. M. Ferrari, A. Corrado, A. Di Domenicantonio, and P. Fallahi, "Autoimmune thyroid disorders," *Autoimmun. Rev.*, vol. 14, no. 2, pp. 174–180, 2015, doi: 10.1016/j.autrev.2014.10.016.

[10] M. P. J. Vanderpump, "The epidemiology of thyroid disease," *Br. Med. Bull.*, vol. 99, no. 1, pp. 39–51, Sep. 2011, doi: 10.1093/bmb/ldr030.

[11] S. De Leo, S. Y. Lee, and L. E. Braverman, "Hyperthyroidism," *Lancet*, vol. 388, no. 10047, pp. 906–918, Aug. 2016, doi: 10.1016/S0140-6736(16)00278-6.

[12] L. Chaker, A. C. Bianco, J. Jonklaas, and R. P. Peeters, "Hypothyroidism," *Lancet*, vol. 390, no. 10101, pp. 1550–1562, Sep. 2017, doi: 10.1016/S0140-6736(17)30703-1.

[13] R. Mullur, Y. Y. Liu, and G. A. Brent, "Thyroid hormone regulation of metabolism," *Physiol. Rev.*, vol. 94, no. 2, pp. 355–382, 2014, doi: 10.1152/physrev.00030.2013.

[14] G. Lippi, M. Montagnana, G. Targher, G. L. Salvagno, and G. C. Guidi, "Relationship between thyroid status and renal function in a general population of unselected outpatients," *Clin. Biochem.*, vol. 41, no. 7–8, pp. 625–627, May 2008, doi: 10.1016/j.clinbiochem.2008.01.014.

[15] D. Formenti, A. Rossi, G. Calogiuri, T. O. Thomassen, R. Scurati, and A. Weydahl, "Exercise Intensity and Pacing Strategy of Cross-country Skiers during a 10 km Skating Simulated Race," *Res. Sports Med.*, vol. 23, no. 2, pp. 126–139, Apr. 2015, doi: 10.1080/15438627.2015.1005298.

[16] A. Dorgalaleh *et al.*, "Effect of Thyroid Dysfunctions on Blood Cell Count and Red Blood Cell Indice," *Iran. J. Pediatr. Hematol. Oncol.*, vol. 3, no. 2, p. 73, 2013, Accessed: Jul. 22, 2026. [Online]. Available: https://pmc.ncbi.nlm.nih.gov/articles/PMC3915449/

[17] S. E. Caglar *et al.*, "Investigation of hemorheology in patients with hyperthyroidism via blood viscosity, erythrocyte deformability and aggregation," *Thyroid Res.*, vol. 18, no. 1, Dec. 2025, doi: 10.1186/S13044-025-00227-W.