Contents lists available atIOCS

Science Midwifery

journal homepage:www.midwifery.iocspublisher.org

Routine hematological profile in tuberculosis patients undergoing treatment at Bakunase Community Health Center, Kupang City

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ARTICLE INFO

Article history:

Received Dec 29, 2025
Revised Feb 4, 2026
Accepted Feb 18, 2026

Keywords:

Erythrocyte
Hematological Profile
Hemoglobin
Hematocrit
Indeks Erythrocite
OAT
Platelet

ABSTRACT

Tuberculosis is a disease caused by the bacterium *Mycobacterium tuberculosis* (M. tuberculosis). Anti-tuberculosis drugs are effective in killing *Mycobacterium tuberculosis* but may also have side effects on various organs, particularly the hematological system. Monitoring through laboratory examinations, particularly hematological tests, can help prevent complications of other diseases. This descriptive study aimed to determine the hematological profile of tuberculosis patients undergoing treatment at the Bakunase Public Health Center in Kupang City. The population in this study comprised TB patients receiving anti-tuberculosis therapy at the Bakunase Public Health Center in Kupang City, with a total sample of 30 patients. The sampling technique used was purposive sampling. The results showed that TB patients at Bakunase Public Health Center were predominantly male (56.7%), in the productive age group of 19–59 years (83.3%), and mainly in the intensive phase of treatment (0–2 months) (60%). In the productive age group, most hematological parameters were within normal limits, particularly erythrocytes, platelets, hemoglobin, and MCHC. Meanwhile, in the non-productive age group, fewer patients had normal hematological values. Based on treatment duration, patients in both the intensive and continuation phases generally had hematological values within normal limits, although percentages varied.

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INTRODUCTION

Tuberculosis is a disease caused by the bacterium *Mycobacterium tuberculosis* (M. tuberculosis). The routes of entry of *Mycobacterium tuberculosis* into the human body include the respiratory tract, the digestive tract, and open wounds on the skin. Most TB infections occur through airborne transmission, namely by inhalation of droplets containing tubercle bacilli originating from infected individuals (Sadewo et al., 2016). This disease typically affects the lungs (pulmonary TB), but it can also spread to other organs; therefore, prevention and appropriate treatment are necessary. In 2022, TB ranked as the second leading cause of death worldwide, and more than 10 million people suffer

from TB each year. With the treatment recommended by the World Health Organization (anti-tuberculosis drugs for 4–6 months), approximately 85% of TB patients can be cured using anti-tuberculosis drugs (OAT) administered for 1–6 months, which are available to treat TB infection (Ryansyah et al., 2023). *Mycobacterium tuberculosis* has become a public health issue in Indonesia. As of February 2, 2023, data from the Ministry of Health indicated that the number of recorded cases had reached approximately 694,808, compared with 644,839 in 2022 (Stephen et al., 2023). According to the Central Statistics Agency (Badan Pusat Statistik) of East Nusa Tenggara Province, in 2024, there were 6,161 cases of tuberculosis in East Nusa Tenggara Province, of which 873 cases occurred in Kupang City, making it the area with the highest number of cases (Badan Pusat Statistik Provinsi Nusa Tenggara Timur, 2024). Tuberculosis treatment is divided into two phases, namely the intensive phase (2–3 months) and the continuation phase. The drugs used in tuberculosis treatment are administered in combination regimens that typically include rifampicin, streptomycin, isoniazid, ethambutol, and pyrazinamide. These drugs can affect bacterial growth, reproduction, and survival (Fauziah Hanif, 2019). The goal of tuberculosis treatment is to rapidly eradicate tubercle bacilli and prevent relapse. Anti-tuberculosis drugs are effective in killing *Mycobacterium tuberculosis* but may also cause side effects in various organs, particularly the hematological system (Witi Karwiti, Wuni Sri Lestari, Nasrazuhdy, 2021). Blood tests play a very important role in monitoring the condition of tuberculosis patients because various hematological parameters change in patients with active TB. Various hematological abnormalities have been reported as a result of anti-TB drug administration. Drug-induced hematological disorders can affect almost the entire hematological spectrum, including red blood cells, white blood cells, platelets, and the coagulation system (Firdayanti, Susanti, 2024). Tuberculosis treatment is not free from side effects caused by anti-tuberculosis drugs. TB treatment leads to reversible changes in hematological parameters. Studies have shown that hematological abnormalities are common in TB, including leukocytosis, monocytosis, lymphocytosis, thrombocytosis, lymphopenia, and anemia (Fadhilah, 2024). During treatment, patients are monitored through laboratory tests. Decreased hematological values in tuberculosis patients are caused by the tuberculosis infection process and by anti-tuberculosis drugs during the early stage of treatment (Aipassa et al., 2024). Hematocrit examination is performed to determine whether a person has anemia and to assess the body's response to ongoing treatment (Bahar et al., 2025). In general, tuberculosis patients experience thrombocytosis (an increased platelet count); however, the use of anti-tuberculosis drugs, particularly rifampicin, is known to cause thrombocytopenia (a decreased platelet count) (Yusuf et al., 2021). Tuberculosis also often causes systemic complications, one of which is anemia. Anemia in TB patients can affect erythrocyte indices, including MCV, MCH, and MCHC examinations (Mukhammad Azmi, 2024). Hematological changes in tuberculosis patients play an important role in the diagnosis and persistent excretion of acid-fast bacilli. Hematological examinations are routine laboratory tests performed at various levels of health care facilities. Monitoring through laboratory examinations, especially hematological tests, can help prevent the occurrence of other disease complications (Tanjung, 2024). Several studies have reported that hematological parameters change during tuberculosis therapy. Before treatment, TB patients often experience anemia, leukocytosis, and increased erythrocyte sedimentation rate (ESR), and after several months of therapy, a reduction in these abnormalities is observed (Ervina Julien Sitanggang, 2023). Previous studies have focused on specific parameters, and few have comprehensively analyzed routine hematological profiles based on TB treatment phases; therefore, the characterization of routine hematological profiles has not been fully described. Therefore, this study aims to comprehensively describe the results of routine hematological examinations, not limited to a single parameter, in TB patients receiving anti-tuberculosis (OAT) treatment at Bakunase Community Health Center. This study is expected to demonstrate the dynamics of hematological parameter changes over the course of therapy and to provide local data from Kupang City to support the monitoring and evaluation of TB treatment at the community health

center level. Overall, the contribution of this study is more practical and local in nature, but it can be scaled to improve the primary health care system in Indonesia. This can reduce the burden of hospital referrals, reduce costs, and increase the efficiency of TB care.

RESEARCH METHOD

This study was a descriptive study aimed at determining the hematological profile of tuberculosis patients undergoing treatment at Bakunase Public Health Center, Kupang City. The population in this study consisted of TB patients receiving treatment and taking anti-tuberculosis drugs at Bakunase Public Health Center, Kupang City, with a total sample of 30 patients. The sampling technique used was purposive sampling, involving patients undergoing the intensive phase (0–2 months) and the continuation phase (2–6 months) of treatment. Sample selection was based on inclusion and exclusion criteria. The inclusion criteria were adult patients aged 19–59 years and elderly patients aged 60 years and above, while the exclusion criteria were pediatric and adolescent patients under 18 years of age. Venous blood samples were then collected, and routine hematological examinations were performed using a hematology analyzer. In this study, the data were analyzed using statistical distribution and frequency tables to present hemoglobin levels, erythrocyte counts, platelet counts, hematocrit values, *Mean Corpuscular Volume* (MCV), *Mean Corpuscular Hemoglobin* (MCH), and *Mean Corpuscular Hemoglobin Concentration* (MCHC) for each variable, namely age, sex, and duration of treatment. A limited sample size affects the strength of interpreting the research results for the broader TB patient population. Nevertheless, this study still provides important preliminary data at the community health center level and can serve as a basis for further research with a larger sample size.

RESULTS AND DISCUSSIONS

Results

The study was conducted at Bakunase Public Health Center from April to May 2024 and involved data from 30 patients who were undergoing treatment at the health center. The collected data consisted of blood test results, including hemoglobin levels, erythrocyte counts, platelet counts, hematocrit values, and erythrocyte indices, which were analyzed based on sex, age, and duration of treatment.

Table 1. Distribution of data amount based on patient characteristics

Characteristics	Amount	
	N	%
Gender		
• Male	17	56,7
• Female	13	43,3
Total	30	100.0
Age		
• 19-59 years (Adult)	25	83,3
• ≥60 years (Elderly)	5	16,7
Total	30	100.0
Duration of treatment		
• Intensive phase (0-2 bulan)	18	60
• Advanced phase (2-6 bulan)	12	40
Total	30	100.0

Based on the study conducted, the majority of respondents were male, totaling 17 respondents (56.7%). Twenty-five respondents were aged 19–59 years (83.3%). Most respondents were in the intensive phase of treatment (60%).

a. Results of Hemoglobin Levels in Pulmonary Tuberculosis Patients Receiving Anti-Tuberculosis Drugs (OAT). Based on the examination of hemoglobin levels, 27 patients (90%) had normal results, while three patients (10%) had abnormal (low) hemoglobin levels.

Table 2. Distribution of hemoglobin levels based on the characteristics of tuberculosis patients at Bakunase Public Health Center in 2025

Characteristics	Hemoglobin				Total	
Gender	Normal		Low			
	N	%	N	%	N	%
Male	16	53,33	1	3,33	17	56,66
Female	11	36,67	2	6,66	13	40,33
Total	27	90	3	10	30	100
Age						
Productive 19-59 years	22	73,33	3	3,33	25	83,33
Non Productive > 60 years	5	16,67	0	0	5	16,67
Total	27	90	3	3,3	30	100
Duration of treatment						
Intensive 0-2 months	15	50	3	10	18	60
Advanced 3-6 months	12	40	0	0	12	40
Total	27	90	3	10	30	100

Based on Table 2, normal hemoglobin levels were more frequently observed in male than female patients, while low levels were predominantly found in males. By age group, normal hemoglobin levels were highest in patients of productive age, with fewer abnormalities compared to the non-productive age group. In terms of treatment duration, normal hemoglobin levels were more common during the intensive phase, whereas no low levels were observed in the continuation phase.

b. Results of Erythrocyte Levels in Pulmonary Tuberculosis Patients Receiving Anti-Tuberculosis Drugs (OAT). The examination of erythrocyte levels showed that 27 patients (90%) had normal results, while three patients (10%) had abnormal (low) erythrocyte levels.

Table 3. Distribution of erythrocyte levels based on the characteristics of tuberculosis patients at Bakunase Public Health Center in 2025

Characteristics	Erythrocyte				Total	
Gender	Normal		Low			
	N	%	N	%	N	%
Male	16	53,33	1	3,33	17	56,66
Female	11	36,67	2	6,66	13	40,33
Total	27	90	3	10	30	100
Age						
Productive 19-59 years	25	83,33	0	0	25	83,33
Non Productive > 60 years	3	10,00	2	6,66	5	16,67
Total	28	93,33	2	36,66	30	100
Duration of treatment						
Intensive 0-2 months	17	56,66	1	3,33	18	60
Advanced 3-6 months	11	36,67	1	3,33	12	40
Total	28	90	2	6,66	30	100

Based on Table 3, the results for erythrocyte levels by sex showed that among males, 53.33% had normal levels and 36.67% had low levels, whereas among females, 36.67% had normal levels and 6.66% had low levels. By age group, patients in the productive age group had 83.33% normal erythrocyte levels, whereas in the non-productive age group, 10% had normal levels and 6.66% had low levels. By treatment duration, patients in the intensive phase showed 56.66% normal erythrocyte levels and 3.33% abnormal levels, whereas in the continuation phase, 36.67% had normal levels and 3.33% had low levels.

c. Results of Platelet Counts in Pulmonary Tuberculosis Patients Receiving Anti-Tuberculosis Drugs (OAT). Based on platelet count examination, all 30 patients (100%) had normal results.

Table 4. Distribution of platelet counts based on the characteristics of tuberculosis patients at Bakunase Public Health Center in 2025

Characteristics	Platelet				Total	
Gender	Normal		Low			
	N	%	N	%	N	%
Male	17	56,66	0	0	17	56,66
Female	13	43,33	0	0	13	40,33
Total	30	100	0	0	30	100
Age						
Productive 19-59 years	25	83,33	0	0	25	83,33
Non Productive > 60 years	5	16,66	0	0	5	16,67
Total	30	100	0	0	30	100
Duration of treatment						
Intensive 0-2 months	18	60	0	0	18	60
Advanced 3-6 months	12	40	0	0	12	40
Total	30	100	0	0	30	100

Based on Table 4, normal platelet counts were observed in 56.66% of male patients and 43.33% of female patients. Normal platelet counts were also found in 83.33% of patients of productive age and 16.66% of those of non-productive age. Regarding treatment duration, 60% of patients in the intensive phase and 40% in the continuation phase had normal platelet counts.

d. Results of Hematocrit Values in Pulmonary Tuberculosis Patients Receiving Anti-Tuberculosis Drugs (OAT). Based on the examination of hematocrit values, 23 patients (76.66%) had normal results, while seven patients (23.33%) had abnormal (low) hematocrit values.

Table 5. Distribution of hematocrit values based on the characteristics of tuberculosis patients at Bakunase Public Health Center in 2025

Characteristics	Hematocrit				Total	
Gender	Normal		Low			
	N	%	N	%	N	%
Male	16	53,33	1	3,33	17	56,66
Female	7	23,33	6	20	13	43,33
Total	23	76,66	7	23,33	30	100
Age						
Productive 19-59 years	20	66,66	5	16,66	25	83,33
Non Productive > 60 years	3	10,00	2	6,66	5	16,66
Total	23	76,66	7	23,33	30	100
Duration of treatment						
Intensive 0-2 months	13	43,33	5	16,66	18	60
Advanced 3-6 months	10	33,33	2	6,66	12	40
Total	23	76,66	7	23,33	30	100

Based on Table 5, normal hematocrit values were more prevalent in male patients than in female patients, while low values were more frequently observed in females. By age group, normal hematocrit values were predominantly observed in patients of productive age, with fewer abnormalities than in the non-productive age group. In terms of treatment duration, normal hematocrit values were more common during the intensive phase, whereas lower values were less frequent in the continuation phase.

e. Results of Erythrocyte Index Values in Pulmonary Tuberculosis Patients Receiving Anti-Tuberculosis Drugs (OAT). Based on the examination of erythrocyte index, normal values were observed in 60% of patients for MCV, 63.33% for MCH, and 86.66% for MCHC.

Table 6. Distribution of erythrocyte index based on the characteristics of tuberculosis patients at Bakunase Public Health Center in 2025

Characteristics	MCV		MCH		MCHC	
Gender	Normal	Low	Normal	Low	Normal	Low
Male	11(36,66 %)	6 (20 %)	12 (40%)	5 (16,66%)	14 (46,66%)	3 (10%)
Female	7 (23,33 %)	6 (20 %)	7 (23,33%)	6 (20%)	12 (40%)	1 (3,33%)
Total	18 (60 %)	12 (40 %)	19 (63,33%)	11 (36,66%)	26 (86,66%)	4 (13,33%)
Age						
Productive 19-59 years	15 (50 %)	10(33,33%)	15 (50%)	10 (33,33%)	21 (70%)	4 (13,33%)
Non Productive> 60years	4 (13,33 %)	1 (3,33%)	4 (13,33%)	1 (3,33%)	5 (16,66%)	0
Total	19 (63,33%)	11(36,66%)	19 (63,33%)	11 (36,66%)	26 (86,66%)	4 (13,33%)
Duration of treatment						
Intensive 0-2 months	8 (26,66%)	10(33,33%)	9 (30%)	9 (30%)	17 (56,66%)	1 (3,33%)
Advanced 3-6 months	10 (33,33%)	2 (6,66%)	11(36,66%)	1 (3,33%)	9 (30%)	3 (10%)
Total	18 (60%)	12 (40%)	20 (66,66%)	10 (33,33%)	26 (86,66%)	4 (13,33%)

Based on Table 6, normal erythrocyte indices were more frequently observed in male patients than in female patients. Among male patients, normal values were recorded for MCV (36.66%), MCH (40%), and MCHC (46.66%). In the productive age group, normal MCV and MCH values were each observed in 50% of patients, predominantly during the continuation phase of treatment (33.33% and 33.66%, respectively), while normal MCHC values were found in 70% of patients, mainly during the intensive treatment phase (56.66%), out of a total sample of 30 patients.

Discussions

The hematological profile examined in this study consisted of hemoglobin, erythrocytes, platelets, hematocrit, and erythrocyte indices. This study showed that pulmonary tuberculosis patients taking anti-tuberculosis drugs were predominantly male rather than female, in accordance with data from the WHO and the Indonesian Ministry of Health (Wahyuni, 2025). The results of hemoglobin examinations in tuberculosis patients with OAT therapy showed that 90% of the hemoglobin levels were normal, and 10% of the hemoglobin levels were abnormal. This is not in line with the research conducted (Achmad et al., 2022), where the hemoglobin levels were more abnormal than normal hemoglobin. Decreased hemoglobin is a common side effect of antituberculosis (TB) medication use. Isoniazid and pyrazinamide, used in the initial treatment of tuberculosis, can inhibit vitamin B6 metabolism, increasing its urinary excretion, and ultimately leading to vitamin B6 deficiency (Sitanggang, 2023). The longer a tuberculosis patient takes antituberculosis medication, the greater the decrease in red blood cell count, which can lead to decreased hemoglobin levels. Vitamin B6 deficiency disrupts heme biosynthesis and causes sideroblastic anemia, while rifampin can cause hemolytic anemia (Permana, 2020). *Mycobacterium tuberculosis* bacteria can cause hematological abnormalities, particularly affecting erythrocytes. Erythrocytes function to transport oxygen to tissues and return carbon dioxide from the lungs. Tuberculosis can affect all hematopoietic processes; when erythrocytes are affected, a reaction occurs in which the lifespan of erythrocytes is shortened to 10–20 days, whereas under normal conditions, erythrocytes have a lifespan of approximately 120 days (Kristianingsih et al., 2024). A low erythrocyte count in tuberculosis patients undergoing anti-tuberculosis drug (OAT) treatment may be caused by rifampicin and isoniazid (INH), which are drugs known to induce red blood cell destruction. Therefore, the longer tuberculosis patients consume these drugs, the more their erythrocyte count decreases. Conversely, an increase in erythrocyte count in tuberculosis patients receiving treatment may be attributed to reduced oxygen supply in the body (Firdayanti, Susanti, 2024). After undergoing OAT treatment, the infection can be controlled, and the healing process in the lung tissue begins. This improvement increases blood oxygenation and may stimulate the body to produce more erythrocytes. In the continuation phase, the side effects of OAT gradually decrease, leading to an increase in erythrocyte production in the body (Fadilah et al., 2024).

In this study, platelet values remained within the normal range, indicating that not all patients experience platelet changes depending on the patient's condition. Some studies show thrombocytosis in tuberculosis patients. Platelets are a key component in the innate immune response to tuberculosis. Activation and signaling of platelets will cause adhesion of platelets and monocytes, which triggers macrophage activation (Ervina Julien Sitanggang, 2023). If there is a decrease in platelet count during tuberculosis treatment, it is caused by the content of anti-tuberculosis drugs (OAT) of the rifampicin type, which causes hematological abnormalities, namely thrombocytopenia. The drug that enters the body is considered an antigen that can activate antibodies. If the drug is absorbed by platelets, then the antibodies against the drug simultaneously damage the platelets (Agung et al., 2025). The administration of rifampicin can cause immune desensitization, so thrombocytopenia more often occurs with intermittent or irregular use (Shyam S Balepur, 2016). A decrease in platelet count can also occur due to depression of the bone marrow, which releases ADP (adenosine diphosphate) as a cause of platelet aggregation that will be destroyed by the reticuloendothelial system. Normal results during treatment are due to the presence of young megakaryocytes, thus maintaining platelet levels within normal limits (Kalma, Rafika, 2019). Anemia during tuberculosis infection can be caused by nutritional deficiencies, impaired iron utilization, bone marrow granulomas, and shortening of red blood cell lifespan (Kassa et al., 2016).

Low hematocrit values in the intensive phase indicate that the patient's body is experiencing an acute inflammatory response due to active tuberculosis infection during the initial administration of isoniazid, rifampicin, pyrazinamide, and ethambutol. Of the 30 tuberculosis patients who received anti-tuberculosis drugs until the end of treatment, two patients (6.66%) were found to have low hematocrit values. The decrease in hematocrit results from reduced hemoglobin levels in the patient's erythrocytes (Hutauruk, 2021). Patients with strong immune responses can fight bacteria that attack red blood cells, thereby preventing changes in hematocrit. Hematocrit values are considered normal when there are no abnormalities in red blood cells in tuberculosis patients (Roosleyn, 2016). Based on the treatment phase, erythrocyte index values in tuberculosis patients during the intensive phase showed normal MCV in 26.66% of patients, normal MCH in 30%, and normal MCHC in 56.66%. Meanwhile, during the continuation phase, normal MCV was found in 33.33% of patients, normal MCH in 36.66%, and normal MCHC in 30%. Side effects of daily consumption of anti-tuberculosis drugs during the intensive treatment phase, involving a combination of isoniazid, rifampicin, pyrazinamide, and ethambutol, may lead to drug accumulation in the body, which can affect erythrocyte indices (Imelda Pongsimpin, Yanti Sunaidi, 2024). Significant differences in hematological parameters have been observed during and after tuberculosis treatment (Reta et al., 2023). In this study, routine hematological parameters remained normal across all treatment phases, with no significant abnormalities. During the intensive phase, although this phase is often associated with the risk of side effects such as anemia due to drug toxicity, the findings showed that patients' hematological parameters remained within normal ranges. This indicates good tolerance to anti-tuberculosis drugs, adequate nutritional status, and relatively good health among patients at the Bakunase Community Health Center in Kupang City. During the continuation phase, treatment is generally less intensive, and patients' bodies tend to recover from the infection. The study findings showed that routine hematological parameters remained stable, indicating that the treatment was effective without disrupting hematopoiesis (blood cell formation), and there was no negative association between the continuation phase and hematological abnormalities. This study has limitations because it only includes data from hematological examination results. Although the sample size is considered moderate, the ultimate goal of this study is to protect TB patients who are at risk of treatment failure and relapse by utilizing routine hematological examinations. This approach may serve as a simple yet effective tool for therapy monitoring. If hematological abnormalities (decreased hematological values) are still found at the end of the treatment period, patients will be given vitamin supplementation to

restore the cells to normal levels. Through regular monitoring of hematological profiles, healthcare workers at community health centers can detect these changes early and implement preventive interventions, such as clinical evaluation, nutritional support, and treatment adjustments as needed.

CONCLUSION

The characteristics of TB patients at Bakunase Public Health Center undergoing anti-tuberculosis drug (OAT) therapy were predominantly male, of productive age (19–59 years), and in the intensive phase of treatment (0–2 months). Overall, the productive age group demonstrated a higher proportion of normal hematological parameters—including hemoglobin, erythrocytes, platelets, hematocrit, MCV, MCH, and MCHC—compared with the non-productive age group. By treatment duration, normal hematological parameters were more frequently observed in patients in the intensive phase, although they were also present in the continuation phase at lower proportions. The recommendations from this study emphasize the importance of strengthening routine hematological monitoring at community health centers as a preventive and surveillance strategy, despite the absence of hematological abnormalities during treatment. This study was limited to a single location; therefore, further research is needed that combines monthly routine hematological measurements with inflammatory biomarkers (CRP, TNF-α) and nutritional indicators (ferritin, vitamin B12) to better understand hematological dynamics in TB patients.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to the Bakunase Public Health Center, all respondents who participated in the study, and all parties who provided support and assistance, enabling the successful conduct of this study.

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