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# Routine Hematology Findings in Pulmonary Tuberculosis Cases at Regional General Hospital of Dr. Pirngadi, Medan, Indonesia

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**Abstract:** Pulmonary Tuberculosis (TB) is an infection of the lung parenchyma caused by *Mycobacterium tuberculosis* and is transmitted via droplets. A routine hematological examination is crucial for evaluating disease progression, complications, and therapeutic responses. Thus, this study aimed to To identify routine hematological characteristics in pulmonary tuberculosis patients in RSUD Dr. Pirngadi Kota Medan. This observational study with cross-sectional design included 105 pulmonary tuberculosis patients, that selected via total sampling technique from 2019 to 2020. Data on demographic characteristics (age, sex, and occupation) and hematological profiles were analyzed. The majority of patients were male (67.6%), aged 46–55 years (24.8%), and worked as self-employed (47.6%). Hematological profiles showed elevated neutrophils (72.4%) and erythrocyte sedimentation rate (53.3%), alongside reduced hemoglobin (58.1%), hematocrit (61%), and lymphocytes (83.8%). Most patients had normal number of leukocytes (52.4%), platelets (63.8%), monocytes (47.6%), eosinophils (87.6%), and basophils (99%). he most characteristic routine hematological changes in pulmonary tuberculosis patients include decreased hemoglobin, hematocrit, and lymphocytes, as well as increased neutrophils and erythrocyte sedimentation rate. These findings emphasize the importance of hematological examination in the diagnosis and monitoring of pulmonary tuberculosis.

**Keywords:** Erythrocyte sedimentation rate; Hemoglobin; Leukocytes; Pulmonary tuberculosis; Routine hematologic

## Introduction

Tuberculosis is a form of infection in the lung parenchyma or extrapulmonary caused by Mycobacterium tuberculosis. This disease can be transmitted through the air through droplets or splashes from coughing, sneezing, or when talking (Brahmadhi & Annisa, 2016; Ramadhan et al., 2017; World Health Organization, 2020b). Various factors reported to contribute to the increasing prevalence of tuberculosis by the World Health Organization (WHO) include low economy, vulnerable age, home environment with poor ventilation, and other vulnerable health conditions (World Health Organization, 2020a).

Tuberculosis is one of the world's serious health problems. This disease is the leading cause of death in

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the infectious disease group after COVID-19 and HIV (World Health Organization, 2021). Tuberculosis is reported to occur in all age groups, both children and adults. However, around 90% of cases are found in adults (Ramadhan et al., 2017; World Health Organization, 2020; Haryanik et al., 2023). Globally, it is estimated that around 10 million people are infected with tuberculosis. Furthermore, WHO has also reported that in 2019 there were 7.1 million cases of tuberculosis, the majority of which were around 58% men and 8% of whom were children. This number has increased compared to previous WHO reports in 2009-2012 (5.7-5.8 million), 2017 (6.4 million), and 2018 (7 million). In fact, in 2020, the WHO reported that the mortality rate from tuberculosis in 2020 was 1.5 million, with 214,000 people being HIV/AIDS patients (World Health Organization, 2020a, 2021).

Tuberculosis as a global health problem is a serious health problem in Indonesia. In 2019, 543,874 TB cases were reported nationally. Meanwhile, according to a report from the North Sumatra Central Statistics Agency (BPS Sumut) in 2020 in Medan City, 12,105 cases of pulmonary tuberculosis were reported. The proportion of incidents based on gender showed a higher number in men (10,396 cases) than women (5,181 cases), with a total of 15,577 cases in 2019 (Badan Pusat Statistik Provinsi Sumatera Utara, 2020).

The diagnosis of pulmonary tuberculosis has so far been carried out through sputum examination and chest X-ray. Currently, the Ministry of Health of the Republic of Indonesia has recommended the use of molecular rapid tests compared to conventional acid-fast bacillus (AFB) staining in the form of Ziel-Nelson, especially in areas with the availability of molecular rapid test machines (Burhan et al., 2020; Khariri, 2020). However, routine blood tests are still the initial step in diagnosing tuberculosis before specific examinations of Mycobacterium tuberculosis bacteria such as AFB examinations or molecular rapid tests. Routine blood tests provide an initial picture of the course of the disease, complications, and response to therapy received by the patient (Banerjee et al., 2015).

In cases of active tuberculosis, changes such as leukocytosis, increased erythrocyte sedimentation rate, and thrombocytopenia are not uncommon. However, these changes tend to return to normal after the patient receives appropriate antituberculosis therapy (Bahar & Amin, 2017). This increase in leukocytes is part of the body's cellular defense system against invasion by Mycobacterium tuberculosis, while the increase in erythrocyte sedimentation rate is related to the release of fibrinogen and globulin during the inflammatory process, which affects the binding between erythrocytes and the formation of rouleaux (Khaironi et al., 2017; Ergiana et al., 2022). In line with tuberculosis infection in the early phase of this disease, anemia is not uncommon as a result of the body's inflammatory response that interferes with the absorption and utilization of iron ). In addition, patients with tuberculosis who receive anti-tuberculosis drug therapy (OAT), especially rifampicin, are reported to sometimes experience thrombocytopenia as a side effect (Kalma et al., 2019).

Several studies have been conducted to analyze the results of routine blood tests in tuberculosis patients in various locations. Lasut et al. (2016) analyzed the hemoglobin and platelet images in tuberculosis patients at RSUP. Pof .Dr. R. D. Kandou Manado reported that the majority of tuberculosis patients experienced anemia, namely 65.67% with thrombocytopenia 5.97% and thrombocytosis 19.40%. Another study by Ellies (2020) in several hospitals in Surabaya showed abnormal changes in neutrophils (73.4%), lymphocytes (83.4%), and monocytes (43.4%).

Although there have been many studies on routine blood tests in tuberculosis patients, comprehensive studies on all hematological parameters in tuberculosis patients, especially in North Sumatra, are still limited. Therefore, this study aims to determine the characteristics of routine hematology in pulmonary tuberculosis patients at Dr. Pirngadi Hospital, Medan City, in the period 2019–2020.

## Method

This observational study used a cross-sectional model conducted at Dr. Pirngadi Regional Hospital, Medan City from November 2021 to December 2021. All research procedures or protocols have been approved by the Health Research Ethics Committee of HKBP Nommensen University with Letter no:

The target population of this study was all patients with pulmonary tuberculosis in the Hospital. While the accessible population of this study was all patients with pulmonary tuberculosis at Dr. Pirngadi Regional Hospital, Medan City for the period 2019-2020, which was 105 patients. Then, sampling was carried out from the accessible population using the saturated sampling method or Total sampling technique. Thus, the sample size of this study is the same as the accessible population, which is 105 people.

The research instrument in this study was carried out using a data collection sheet containing sample codes, patient initials, age, gender, occupation, hemoglobin levels, leukocyte count, platelet count, hematocrit, erythrocyte sedimentation rate, and leukocyte differential count.

This study conducted secondary data collection taken from medical records of patients diagnosed with

pulmonary tuberculosis at Dr. Pirngadi Regional Hospital, Medan City in the period January 2019 to December 2020.

The research data obtained from the research instrument were then analyzed through several stages including editing, coding, data entry, cleaning, saving, and data analysis. All data in this study were analyzed with descriptive statistics using the IBM SPSS 22 application. All data are presented in tabular and textural forms.

## Result and Discussion

This observational study was conducted at one of the government-owned hospitals in Medan City, namely Dr. Pirngadi Hospital. This hospital is one of the government-owned type B hospitals located at Jl. Prof. HM. Yamin Sh No. 47, Perintis, Medan Timur District, Medan City, North Sumatra.

A description of the socio-demographic characteristics in the form of age, gender, and occupation of all pulmonary tuberculosis patients at Dr. Pirngadi Regional Hospital, Medan City can be seen in the following table.

**Table 1.** Socio-Demographic Characteristics of Tuberculosis Patients

| Socio-Demographic Characteristics | Frequency | Percentage (%) |
|---|---|---|
| Age | | |
| Late Adolescence (17-25 years) | 12 | 11.4 |
| Early Adulthood (26-35 years) | 16 | 15.2 |
| Late Adulthood (36-45 years) | 17 | 16.2 |
| Early Old Age (46-55 years) | 26 | 24.8 |
| Late Old Age (56-65 years) | 20 | 19.0 |
| Seniors (> 65 years) | 14 | 13.3 |
| Gender | | |
| Male | 71 | 67.6 |
| Female | 34 | 32.4 |
| Work | | |
| Self-employed | 50 | 47.6 |
| Housewife | 23 | 21.9 |
| Civil servant | 10 | 9.5 |
| Others | 10 | 9.5 |
| Private employees | 8 | 7.6 |
| Student | 4 | 3.8 |

From the table data above, it can be seen that there are three characteristics assessed in this study. The majority of patients with pulmonary tuberculosis at Dr. Pirngadi Hospital, Medan City are men (67.6%) who come from the Early Elderly age group (46-55 years) (24.8%). The results of this study are in line with the research of Banerjee et al. (2015), which reported that the majority of tuberculosis patients at the Tertiary Care Hospital came from the age group of 41-50 years (38.5%). Another study conducted by Fitria et al. (2017) also reported results that were not much different, where the majority of tuberculosis patients at the Microscopic Referral Health Center also came from the age groups of 45-54 years and 55-64 years (26.5%) (Fitria et al., 2017). Furthermore, the stratification of age and gender characteristics in pulmonary tuberculosis patients at Dr. Pirngadi Hospital. Pirngadi Medan City can be seen in the following bar chart.

From the figure 1, it can be seen that the distribution of pulmonary tuberculosis patients at RSUD Dr. Pirngadi is mostly found in women. This can be seen from the sex ratio value in each age group, with the distribution of sex ratio starting from the youngest age, namely early adolescence of 0.71, early adulthood of 3.00, late adulthood of 4.67, early elderly of 1.36, late elderly of 4, and the oldest elderly of 1.8.

Older age groups have a higher risk of contracting tuberculosis. This is in line with the patient's immune system which decreases with age. Thus, pulmonary tuberculosis patients from this age group are the age group that is more susceptible to Mycobacterium tuberculosis infection (Sadewo et al., 2016; Maphasa et al., 2021).

In addition, this study also shows that the percentage of pulmonary tuberculosis patients from the adult age group, both young and old, is still quite high. This high percentage is related to the daily activities of patients, especially those who work to meet the needs of their lives and families. Environmental factors in the workplace, such as humidity, poor ventilation, and lack of cleanliness, also affect susceptibility to Mycobacterium tuberculosis infection. The high frequency of direct contact through meetings and daily activities further increases the possibility of exposure to bacteria that cause tuberculosis. Thus, the adult and elderly age groups require special attention in the prevention and control of this disease (Sadewo et al., 2016).

In addition to age, this study also assessed the distribution of pulmonary tuberculosis incidence by gender, and the majority of patients in this study were male. This is in line with the results of a study by Aravindhan et al. (2022) which reported that the majority of pulmonary tuberculosis patients in the Tamil Nadu State Community, India, were male (62%). Similar results were also reported by Gupta et al. (2021), who reported that 60% of pulmonary tuberculosis patients in a hospital in Delhi State were male. This finding is related to the habits of men who have a higher tendency to smoke and drink alcohol than women. These habits can reduce the body's immune system so that it is more easily infected with Mycobacterium tuberculosis (Aravindhan et al., 2022; Gupta et al., 2021; Khaironi et al., 2017).

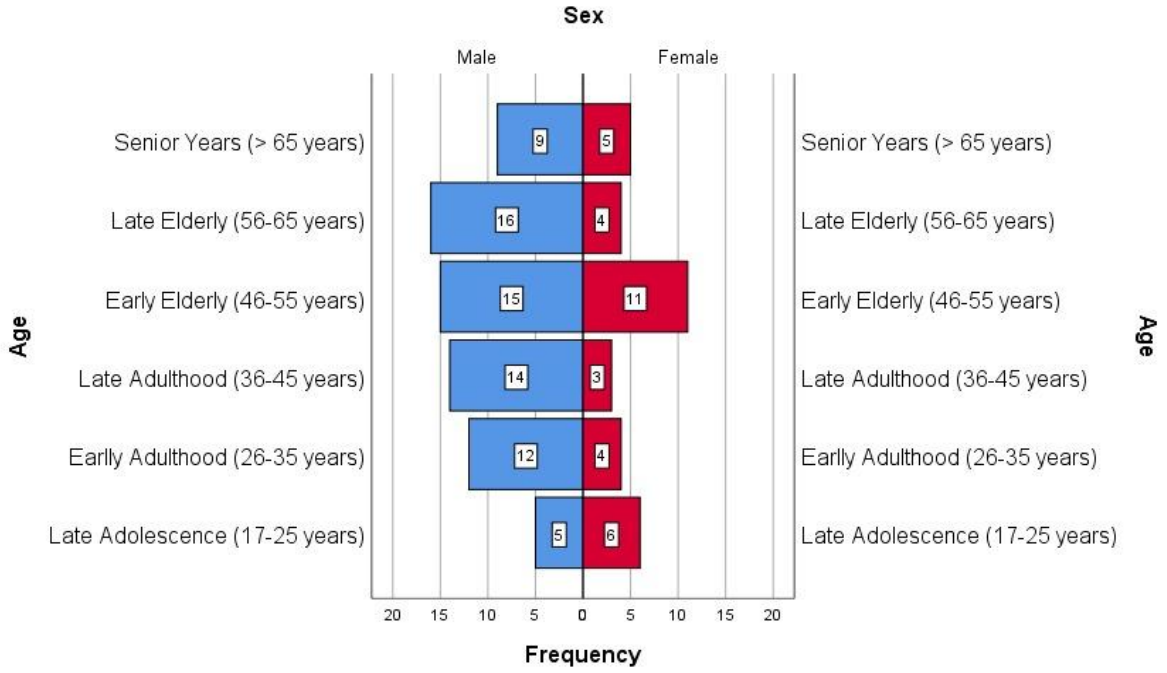


**Figure 1.** Bar chart of age and gender in tuberculosis patients at Dr. Pirngadi Regional Hospital, Medan City

**Table 2.** Routine Hematology Characteristics of Pulmonary Tuberculosis Patients

| Routine Hematology Characteristics | Frequency | Percentage (%) |
|---|---|---|
| Hemoglobin | | |
| Increase | 4 | 3.8 |
| Normal | 40 | 38.1 |
| Decrease | 61 | 58.1 |
| Leukocytes | | |
| Increase | 47 | 44.8 |
| Normal | 55 | 52.4 |
| Decrease | 3 | 2.9 |
| Platelets | | |
| Increase | 33 | 31.4 |
| Normal | 67 | 63.8 |
| Decrease | 5 | 4.8 |
| Haematocrit | | |
| Increase | 3 | 2.9 |
| Normal | 38 | 36.2 |
| Decrease | 64 | 61.0 |
| Erythrocyte Sedimentation Rate | | |
| Increase | 56 | 53.3 |
| Normal | 49 | 46.7 |
| Decrease | 0 | 0 |

In addition, based on other socio-demographic characteristics, namely occupation, the majority of patients with pulmonary tuberculosis at Dr. Pirngadi Regional Hospital, Medan City, were self-employed, amounting to 50 people (47.6%).

This result is consistent with the findings of Ruditya (2017), who reported that 55.3% of tuberculosis patients were self-employed or private employees. Environmental factors and activity patterns that do not support cleanliness and health can be additional risk factors for this group (Ruditya, 2017; Utami et al., 2018; Fitri et al., 2018; Siallagan et al., 2023; Hidayat & Firdhania, 2023; Sari et al., 2017; Wulandini et al., 2020; Rumimpunu et al., 2018; Netty et al., 2018; Mulidan et al., 2021).

The analysis was then continued to assess the routine hematological characteristics of Pulmonary Tuberculosis patients at Dr. Pirngadi Regional Hospital, Medan City and the routine hematological characteristics can be seen in Table 2.

From the data in Table 2, it can be seen that there are several routine blood parameters evaluated in this study, including hemoglobin, leukocytes, platelets, hematocrit, and erythrocyte sedimentation rate. The majority of patients in this study showed blood test results in the form of decreased hemoglobin (58.1%) and hematocrit (61.0%). While other blood test results in the form of leukocytes (52.4%) and platelets (63.8%) were within normal limits. Finally, the erythrocyte sedimentation rate tended to increase in 56 people (53.3%).

Hemoglobin, as one of the routine blood test parameters, shows that the majority of pulmonary tuberculosis patients at Dr. Pirngadi Regional Hospital, Medan City showed a decrease in hemoglobin (58.1%). This is in line with the results of a study by Sadewo et al. (2016) which reported that the majority of patients at the West Kalimantan Province Lung Disease Treatment Unit showed a decrease in hemoglobin levels of 76.4%. Another study conducted by Kalma et al. (2019) also

reported similar results, namely that 57.1% of patients at the Maccini Sawah Health Center also experienced a decrease in hemoglobin levels (Sadewo et al., 2016; Kalma et al., 2019).

Hemoglobin levels often decrease in patients with chronic infections, including tuberculosis. This decrease in hemoglobin is often found in the form of chronic disease anemia as a result of the release of various cytokines as part of chronic inflammation. Increased cytokines will disrupt the absorption and utility of iron. Furthermore, cytokines can also directly inhibit erythropoietin, so that the need for iron will decrease, the release of iron into the circulation will decrease, and iron absorption will decrease. Several cytokines that have been reported to interfere with the process of hemoglobin formation include Tumor Necrotizing Factor (TNF)-α, IL (Interleukin)-1, IL-6, and IL-8. In addition to the cytokines in the body, the use of OAT drugs has also been reported to decrease hemoglobin levels because isoniazid and piranizamide can interfere with the metabolism of vitamin B6 which is a cofactor in pyridoxal phosphate in the heme synthesis process. Thus, this causes sideroblastic anemia. Another OAT drug that has also been reported to cause anemia is rifampicin, which causes hemolytic anemia (Kalma et al., 2019).

In addition to hemoglobin, this study also reported that the majority of tuberculosis patients at Dr. Pirngadi Hospital, Medan City had normal leukocyte counts. This finding is in line with the study by Rampa et al. (2020) at Dr. Soedibjo Sardadi Navy Hospital which reported that 81% of pulmonary tuberculosis patients (30 patients) showed normal leukocyte counts (Rampa et al., 2020). Pulmonary tuberculosis, caused by Mycobacterium tuberculosis, is a lung parenchymal infection that triggers the body's immune response, both innate and adaptive. Leukocytes play an important role in eliminating bacteria that cause infection. In the early stages of infection, the number of leukocytes increases to eliminate bacteria, but will return to normal as the number of bacteria decreases due to OAT treatment. Therefore, the results of this study confirm that the majority of pulmonary tuberculosis patients at Dr. Pirngadi Hospital, Medan City have normal leukocyte counts (Khaironi et al., 2017; Rampa et al., 2020; Talakua et al., 2021).

The inflammatory process that occurs in cases of pulmonary tuberculosis not only involves inflammatory cells, but also involves the release of various pro-inflammatory peptide compounds including fibrinogen and globulin proteins. These proteins will cause erythrocytes to stick together and form roeleaux, which causes the ESR value to increase. Thus, routine examination of ESR values can be used as an indicator of disease severity and as a monitoring tool for response to treatment, which decreases and returns to normal values can also be an indicator of healing (Kasih & Sulastina, 2019). These results are in line with the findings of the current study, which reported that the majority of pulmonary tuberculosis patients at Dr. Pirngadi Hospital, Medan City experienced an increase in ESR of 53.3%. This finding is also supported by a study conducted by Sulochana et al. (2018), which reported an increase in ESR values in 75 patients (82%) with pulmonary tuberculosis in India during the period January to August 2017 (Sulochana et al., 2018).

Routine blood test parameters that were also assessed in this study were platelets and it was found that the majority of pulmonary tuberculosis patients at Dr. Pirngadi Hospital, Medan City still had normal platelet counts, namely 67 patients (63.8%). The results of this study are in line with the results of a study by Lasut et al. (2016) at Prof. Dr. R.D. Kandou Hospital, Manado, which showed that there were 50 patients with normal platelet counts (74.6%) in pulmonary tuberculosis patients. This study is also in line with the study of Fathana et al. (2016) conducted at NTP Hospital, which showed that there were 44 patients with normal platelet counts (25.6%).

**Table 3.** Profile of Leukocyte Types in Pulmonary Tuberculosis Patients at Dr. Pirngadi Regional Hospital, Medan City

| Characteristics of Leukocyte Count Types | Frequency | Percentage (%) |
|---|---|---|
| Neutrophils | | |
| Increase | 76 | 72.4 |
| Normal | 26 | 24.8 |
| Decrease | 3 | 2.9 |
| Lymphocytes | | |
| Increase | 0 | 0.0 |
| Normal | 17 | 16.2 |
| Decrease | 88 | 83.8 |
| Monocytes | | |
| Increase | 49 | 46.7 |
| Normal | 50 | 47.6 |
| Decrease | 6 | 5.7 |
| Eosinophil | | |
| Increase | 13 | 12.4 |
| Normal | 92 | 87.6 |
| Decrease | 0 | 0 |
| Basophil | | |
| Increase | 1 | 1.0 |
| Normal | 104 | 99.0 |
| Decrease | 0 | 0 |

An increase in the number of platelets can be stimulated by platelet stimulating factor in response to inflammation and this increase can be a sign of acute bleeding, pulmonary tuberculosis patients with

hemoptysis are a condition that can be found (Rampa et al., 2020). Some conditions that can cause an increase in the number of platelets include allergies, heart attacks, physical exercise, iron deficiency, vitamin deficiency, and infection (tuberculosis) (Sinaga, 2019). Meanwhile, a decrease in the number of platelets, especially in tuberculosis patients, can also be caused by the side effects of OAT drugs, but this is also an indicator of the success of OAT in suppressing bacterial growth (Argan & Elq, 2021; Rampa et al., 2020).

Lastly, the routine blood parameter that was also analyzed in this study was hematocrit. The majority of pulmonary tuberculosis patients at Dr. Pirngadi Hospital, Medan City experienced a decrease in ESR in 64 patients (61.0%). This is in line with the results of a study by Kassa et al. (2016) which reported a decrease in hematocrit levels in 35.7% of pulmonary tuberculosis patients at Gondar University Teaching Hospital, Southwest Ethiopia. The decrease in hematocrit was mostly due to a decrease in hemoglobin as a major component that makes up blood.

Furthermore, this study then analyzed the number of types of leukocyte cells described in Table 3. From the data in Table 3, it can be seen that the majority of pulmonary tuberculosis patients at Dr. Pirngadi Regional Hospital, Medan City showed a number of neutrophils (72.4%), but the number of lymphocytes decreased (83.8%). Meanwhile, other types of leukocytes including monocytes (47.6%), eosinophils (87.6%), and basophils (99.0%) tended to be within normal limits.

Although the number of leukocytes in patients in this study was within normal limits, further analysis was performed to evaluate the number of each type of leukocyte. The majority of pulmonary tuberculosis patients in this study showed an increase in the number of neutrophils by 72.4%. This finding is in line with Herlando's (2019) study which reported an increase in the number of neutrophils in 55% of tuberculosis patients at Jayapura Regional Hospital. This increase in neutrophils indicates the initial process of the body's immune response, especially against bacterial or viral invasion (Sinaga, 2019). Conversely, there was a decrease in the number of lymphocytes in pulmonary tuberculosis patients at Dr. Pirngadi Regional Hospital, Medan City. This decrease is in line with the study of Mandal et al. (2016) and Shafee et al. (2014), which reported a decrease in lymphocytes by 57.8% at the Mahatma Gandhi Mission Campus, New Mumbai. However, another study by Khaironi et al. (2016) stated that an increase in lymphocytes (lymphocytosis) can be a marker of active pulmonary tuberculosis infection. In active cases, T lymphocytes release IL-1 to activate macrophages, which then release IL-2 to strengthen the body's immune response to tuberculosis infection (Khaironi et al., 2017).

On the other hand, the number of monocytes in patients in this study was still within normal limits. This result is in accordance with Sinaga (2019) study at Jayapura Regional Hospital, which reported that 75% of pulmonary tuberculosis patients had normal monocyte counts. In cases of pulmonary tuberculosis, monocytes that are activated into macrophages play an important role in the phagocytosis of Mycobacterium tuberculosis and the formation of tubercles. An increase in the number of monocytes usually indicates the formation of active tubercles in tuberculosis patients, especially in cases of pulmonary tuberculosis (Sinaga, 2019).

Based on the number of leukocytes and their differential counts, pulmonary tuberculosis patients in this study showed normal leukocyte values with a differential count pattern in the form of an increase in the number of neutrophils, especially mature neutrophils or better known as shift to the right. The shift to the right phenomenon generally occurs in the early phase of bacterial or viral invasion. A further decrease in the number of lymphocytes indicates that the patient is not experiencing active pulmonary tuberculosis (Honda et al., 2016). Therefore, it can be concluded that the patient is in the healing phase, which is supported by the consumption of anti-tuberculosis drugs (OAT). However, the possibility of co-infection by other bacteria during the treatment period cannot be completely ruled out.

## Conclusion

The results of this study indicate that the majority of pulmonary tuberculosis patients at Dr. Pirngadi Hospital, Medan City are male (67.6%) aged 46–55 years (24.8%) and work as self-employed (47.6%). Routine blood tests showed a decrease in hemoglobin (58.1%) and hematocrit (61.0%) accompanied by an increase in the erythrocyte sedimentation rate (53.3%). Most patients had normal leukocyte counts, but the differential leukocyte count showed significant changes, namely an increase in neutrophils (72.4%) and a decrease in lymphocytes (83.8%), which indicated a chronic inflammatory pattern. These findings underline the typical hematological changes in pulmonary tuberculosis patients, providing additional insights for disease diagnosis and monitoring.

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**Author Contributions**
Conceptualization, validation, resources, project administration, funding acquisition, J.R.S. and G.M.C.S.; methodology, S. and J.R.S.; software, R.C.S.; formal analysis, data curation, J.R.S., G.M.C.S., and N.E.R.S.; Investigation, N.E.R.S. and R.C.S.; Writing—original draft preparation, G.M.C.S. and R.C.S.; Writing—review and editing, G.M.C.S. and N.E.R.S.; Visualization, S.; Supervision, J.R.S.

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**Conflicts of Interest**
The authors declare no conflict of interest.

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