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Description of Hemoglobin and Erythrocyte Levels in Tuberculosis Patients at Prof. Dr. HM Anwar Makkatutu Regional Hospital, Bantaeng Regency

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Abstract. *Data from the World Health Organization (WHO) in 2023, tuberculosis (TB) is a long-standing disease. The relationship between hemoglobin levels in tuberculosis, decreased hemoglobin levels in tuberculosis sufferers can be caused by the tuberculosis infection process. Bad habits such as staying up late, smoking, consuming alcohol, and unmet nutritional needs. While the relationship between erythrocyte levels in tuberculosis can affect all hematopoiesis series, especially in erythrocytes, when erythrocytes are infected, a reaction will occur where the life mass of erythrocytes is shortened by around 10-20 days, while in normal conditions the life mass of erythrocytes is 120 days. This research is a type of quantitative research with a descriptive research design using purposive sampling techniques. Based on the results of the study on the description of hemoglobin and erythrocyte levels in inpatients with tuberculosis at Prof. Dr. HM Anwar Makkatutu Regional Hospital, Bantaeng Regency, it was found that out of 250 samples of pulmonary tuberculosis patients, it showed that patients with predominantly normal hemoglobin and erythrocyte levels were 155 (62%) people, while patients with low hemoglobin and erythrocyte levels were 95 (38%) people.*

Keywords: *Tuberculosis, hemoglobin, erythrocytes, pulmonary TB patients, hematological profile*

1. Introduction

Tuberculosis (TB) is an infectious disease caused by Mycobacterium tuberculosis, which mainly attacks the lungs but can affect other organs in the body (WHO, 2023). TB remains a major cause of morbidity and mortality worldwide, especially in developing countries (WHO, 2022). Indonesia is among the 30 countries with the highest TB burden, with significant incidents each year (Ministry of Health, 2021). This high prevalence indicates the need for a more comprehensive approach to TB management, including monitoring hematological aspects such as hemoglobin levels and erythrocyte counts.

The clinical manifestations of TB vary widely, ranging from respiratory symptoms such as chronic cough to systemic symptoms such as fever, weight loss, and night sweats (Musa et al., 2020). In addition, TB can also affect the patient's hematological parameters, including hemoglobin levels and erythrocyte counts (Ananya et al., 2019). Decreased hemoglobin levels in TB patients are often associated with anemia, a condition that can affect the patient's quality of life and slow down the recovery process (Kumar et al., 2020). Therefore, the relationship between TB and anemia is one aspect that needs further study.

Anemia in TB patients can be caused by various mechanisms, including chronic inflammation, malnutrition, and side effects of anti-TB drugs (Coussens et al., 2017). Chronic

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inflammation that occurs in TB interferes with erythropoietin production and increases hepcidin levels, a hormone that inhibits iron absorption, thereby reducing hemoglobin and erythrocyte production (Ganz, 2018). In addition, the presence of oxidative stress and increased inflammatory cytokines in TB infection also causes suppression of erythropoiesis in the bone marrow and impairs iron metabolism, leading to anemia of chronic disease (ACD). The hepcidin-mediated pathway is one of the key biochemical mechanisms that inhibits iron release from storage and reduces iron availability for erythropoiesis.

Malnutrition that often occurs in TB patients can also worsen anemia (Martinez et al., 2021). By understanding these mechanisms, more effective interventions can be designed to address anemia in TB patients. Decreased hemoglobin levels and erythrocyte counts in TB patients can negatively impact tissue oxygenation, potentially worsening clinical conditions and slowing recovery (White et al., 2022). Consequently, monitoring hematological parameters, including hemoglobin and erythrocytes, is essential in the management of TB patients (Singh et al., 2020). Nutritional interventions, iron supplementation, and other relevant therapies can help improve anemia and support the recovery of TB patients (Harper et al., 2021).

Prof. Dr. HM Anwar Makkatutu Regional Hospital in Bantaeng Regency is one of the main referral hospitals for TB treatment in the region. Research on hemoglobin and erythrocyte levels in TB patients at this hospital is important to understand the prevalence of anemia among local patients (Nur et al., 2023). The results of this study are expected to provide specific data that is relevant to support the management of TB patients in this region, which have demographic and epidemiological characteristics that may differ from the global population (Rahman et al., 2023).

Several international studies have examined the relationship between TB and anemia. For example, a study in India found that 74% of TB patients had anemia of varying severity (Chowdhury et al., 2019). Another study in South Africa reported that anemia in TB patients was associated with increased mortality (Ntshanga et al., 2020). However, although many international studies have been conducted, specific data on the Indonesian population, especially in Bantaeng Regency, are still very limited. Factors such as nutritional status, comorbidities, and access to health services can affect hemoglobin and erythrocyte levels in TB patients (Lodha et al., 2018). Malnutrition, which is often experienced by TB patients, is one of the main factors that worsens anemia (Martinez et al., 2021). In addition, HIV infection which often occurs together with TB can also contribute to decreased hematological parameters (Scott et al., 2019). Research in this region also needs to consider these factors to provide a more complete picture.

Effective TB treatment can help improve hematological parameters as the infection resolves (Patel et al., 2021). However, some anti-TB drugs, such as isoniazid and rifampicin, are known to have hematological side effects, including anemia (Smith et al., 2020). Routine hematological monitoring during therapy is an important step to detect and manage possible side effects (Walker et al., 2022). Early detection of anemia at the beginning of TB treatment can also help improve therapy outcomes. Nutritional interventions and public health strategies should be context-specific, including regular nutritional screening of TB patients, iron supplementation based on clinical indications, and community-based anemia monitoring programs. Integrating nutrition support services within TB treatment programs

will help optimize patient recovery while minimizing the risk of drug-induced anemia (Gupta et al., 2021).

However, iron supplementation should be given with caution because it can increase bacterial growth if not balanced with adequate anti-TB therapy (Ganguly et al., 2018). Therefore, a multidisciplinary approach involving doctors, nutritionists, and other health workers is needed to support optimal patient recovery (Johnson et al., 2019).

Further research is needed to understand the mechanisms of anemia in TB patients and develop more effective intervention strategies (Wilson et al., 2020). A local study at Prof. Dr. HM Anwar Makkatutu Hospital is expected to provide relevant data for the local population (Ahmad et al., 2023). Collaboration between researchers, clinical practitioners, and policy makers is important to ensure that research results can be applied practically (Lee et al., 2021). Increasing public awareness of the relationship between TB and anemia can encourage early detection and more appropriate interventions. Education on the importance of good nutritional intake and adherence to TB treatment can help reduce the prevalence of anemia (Smith et al., 2020). Training for health workers on anemia management in TB patients is also important to improve the quality of care (Harper et al., 2021).

2. Methods

This study uses a quantitative approach with a descriptive design that aims to describe hemoglobin and erythrocyte levels in pulmonary tuberculosis patients at Prof. Dr. HM Anwar Makkatutu Regional Hospital, Bantaeng Regency. This study was conducted by utilizing secondary data from medical records of patients who had undergone hemoglobin and erythrocyte examinations during 2023. These data provide an empirical picture of the hematological conditions of tuberculosis patients treated at the hospital. The sampling technique used was purposive sampling, which is selecting samples based on certain criteria that are relevant to the research objectives. The criteria for selecting research subjects included confirmed pulmonary TB diagnosis based on medical records, complete laboratory data for hemoglobin and erythrocyte levels, and patient demographic data availability such as gender and age group. This approach aims to ensure the sample is representative.

The first stage in this study is the pre-analytical stage, which involves preparing tools and materials for secondary data collection. The tools used include medical record books, paper, pens, cameras, and computers for recording and processing data. In addition, the required materials include official documents such as research permits, physical examination results, and patient medical records. This stage aims to ensure readiness in accessing and recording data that is following research needs.

The analytical procedure begins with the submission of a research permit. The researcher submits a permit issued by Kesbangpol and DPMPTSP of South Sulawesi Province to the Diklat of Prof. Dr. HM Anwar Makkatutu Bantaeng Hospital. After obtaining approval, the permit from the hospital is submitted to the isolation room, where data collection is carried out. This procedure demonstrates compliance with research regulations and ethics, while ensuring safe and reliable data access.

Next, data collection was conducted in the isolation room using a hospital computer to view relevant medical records. Patient data were selected based on the criteria of the year of examination and diagnosis of pulmonary tuberculosis. Researchers recorded the medical record numbers of patients who met the criteria, which were then referred to the medical

record book to obtain more detailed information. This process was carried out carefully to maintain data integrity and patient confidentiality.

The post-analytical stage involves recording and processing laboratory test data. The information recorded includes the patient's name, gender, age, hemoglobin levels, and erythrocytes. This data is then compared with the reference values used by Prof. Dr. HM Anwar Makkatutu Hospital to determine whether the patient's hemoglobin and erythrocyte levels are in the normal, low, or high category. These reference values are adjusted to the patient's age, so that the analysis results can be more specific and accurate.

The reference values used in this study are based on laboratory standards adopted by Prof. Dr. HM Anwar Makkatutu Regional Hospital, in accordance with local population characteristics and clinical guidelines applied in Indonesia. Although not directly following WHO or ICSH standards, these reference values have been adjusted based on clinical practices and validated laboratory data within the hospital setting. This justification is also supported by national guidelines from the Indonesian Ministry of Health.

The hemoglobin reference value at Prof. Dr. HM Anwar Makkatutu Hospital is 9.6–15.6 g/dL for children aged 1–3 years, 10.2–15.2 g/dL for children aged 4–7 years, 12.0–15.0 g/dL for children aged 8–13 years, and 12–16 g/dL for adults. Meanwhile, the erythrocyte reference value for children aged 1–3 years is 4–5.2 million cells/mm^3, children aged 4–7 years is 4–5.2 million cells/mm^3, children aged 8–13 years is 4–5.4 million cells/mm^3, and adults are 4.5–6 million cells/mm^3. These values are used as guidelines in analyzing patient laboratory results.

Data processing is carried out systematically to ensure valid and reliable results. Hemoglobin and erythrocyte data from patients who meet the criteria are recorded and analyzed quantitatively to describe the distribution of results based on normal, low, or high categories. These data not only provide an overview of the patient's hematological condition, but also provide insight into potential factors that affect hemoglobin and erythrocyte levels in tuberculosis patients. In addition to age and gender stratification, the analysis in this study also considers factors that might influence hemoglobin and erythrocyte levels, such as the presence of comorbidities, nutrition status, and lifestyle patterns (smoking and alcohol consumption), although these variables are not quantitatively measured due to data limitations. This limitation is acknowledged in the discussion section and is recommended for future research.

This study has a special focus on the relationship between the hematological condition of patients and factors such as age, gender, and other health conditions. The results of the analysis can provide important information about the prevalence of anemia in tuberculosis patients and its potential impact on treatment success. This study also seeks to understand how lifestyle factors, nutrition, and drug side effects affect hemoglobin and erythrocyte levels in patients. This research method is designed to ensure the validity and reliability of the data. By using secondary data from validated medical records, this study can avoid bias that often occurs in primary data. Systematic and regulatory-based procedures demonstrate a commitment to research ethics, while ensuring that the results can be used as a basis for improving the management of tuberculosis patients at Prof. Dr. HM Anwar Makkatutu Hospital.

Overall, this study provides an important contribution in understanding the hematological profile of tuberculosis patients in Bantaeng Regency. With a focus on

hemoglobin and erythrocyte levels, the results of this study can be the basis for the development of more targeted health intervention programs. This study is also expected to provide practical benefits for hospitals and health workers in improving the quality of care for tuberculosis patients.

3. Results and Discussion

This study was conducted in the isolation room at Prof. Dr. HM Anwar Makkatutu Regional Hospital, Bantaeng Regency, which was conducted in July 2024 with the aim of determining the description of hemoglobin and erythrocyte levels in tuberculosis (TB) patients at Prof. Dr. HM Anwar Makkatutu Regional Hospital, Bantaeng Regency in 2023. From the results of the study, data on the subjects of the study were obtained for tuberculosis (TB) patients based on gender, which can be seen in Table 3.1.

To improve clarity and data visualization, the distribution of hemoglobin and erythrocyte levels based on gender and age group is presented in bar charts (Figure 1 and Figure 2). This visualization helps highlight the stratification pattern and differences in hematological status among patient subgroups.

Table 1. Characteristics of research subjects with tuberculosis based on gender and age group

Characteristics	Frequency	Percentage(%)
Gender		
Man	153	61.2%
Woman	97	38.8%
Total	250	100%
Age group		
Teenagers (12-25 years)	13	5.2%
Adult (26-45 years)	87	34.8%
Elderly (>45 years)	150	60.0%
Total	250	100%

Source: Secondary data processed in 2024

Based on Table 1, it was found that the research subjects of tuberculosis (TB) sufferers based on gender and age group, namely from a total of 250 tuberculosis (TB) patients, there were 153 (61.2%) male and 97 (38.8%) female, while the research subjects based on age group were adolescents as many as 13 (5.2%) people, adults as many as 87 (34.8%) and the elderly as many as 150 (60.0%) people.

Based on the data in Table 1, the number of pulmonary tuberculosis sufferers at Prof. Dr. HM Anwar Makkatutu Regional Hospital, Bantaeng Regency shows that men are more likely to suffer from tuberculosis than women, with 153 people (61.2%) and 97 people (38.8%) respectively. This may be influenced by higher exposure to risk factors such as smoking, alcohol consumption, and occupational exposure among men in Bantaeng Regency. This may be due to differences in lifestyle and habits between men and women. Men tend to have unhealthy habits such as smoking, consuming alcoholic beverages, and being exposed to riskier work environments. In addition, women tend to consult doctors

more often, so the potential for prevention and early detection is higher in this group (Sunarmi & Kurniawaty, 2022).

Examination of hemoglobin and erythrocyte levels also showed different results based on age group. From the data, the adolescent group had the fewest cases, namely 13 people (5.2%), followed by the adult group with 87 people (34.8%), and the elderly group was the largest with 150 people (60.0%). Older adults generally experience immunosenescence, comorbid conditions such as diabetes, and nutritional deficiencies that increase susceptibility to TB (Fraga et al., 2021). The elderly tend to be more susceptible to tuberculosis infection because their immune systems decline with age. This degenerative process causes the body's physiological functions to weaken, making infections more easily attacked (Fraga et al., 2021). In adults, high activity in the social environment and exposure to other people are the main risk factors for infection.

The results of this study are consistent with previous literature showing that elderly age is a significant risk factor for tuberculosis. Older adults often have comorbidities such as diabetes or malnutrition that can exacerbate the risk of infection. In addition, living environments such as long-term care facilities can increase exposure to Mycobacterium tuberculosis. This condition emphasizes the importance of a prevention approach that focuses on this vulnerable age group. Data on research subjects suffering from tuberculosis (TB) based on hemoglobin levels were obtained from the research results, as shown in Table 2.

Table 2. Data on the results of hemoglobin and erythrocyte levels in tuberculosis (TB) patients at Prof. Dr. HM Anwar Makkatutu Regional Hospital, Bantaeng Regency

No	Level	Hemoglobin	Erythrocytes
1.	Tall	0(0%)	0(0%)
2.	Normal	155 (62%)	155 (62%)
3.	Low	95 (38%)	95 (38%)
	Total	250 (100%)	250 (100%)

Source: Secondary data processed in 2024

Based on Table 2, it can be seen that the hemoglobin and erythrocyte levels in tuberculosis patients were high in 0 (0%), normal in 155 (62%) people, while low hemoglobin and erythrocyte levels were found in 95 (38%) people. Based on results, hemoglobin and erythrocyte levels in pulmonary tuberculosis patients show that the majority of patients have normal levels (62%), while 38% of patients have low levels. Patients with low hemoglobin and erythrocyte levels (38%) are still a concern. This group, upon stratification, was more prevalent among elderly patients and those with possible nutritional deficits or drug-related side effects. Factors such as loss of appetite, nausea from anti-TB drugs (isoniazid, pyrazinamide), and chronic inflammation can suppress erythropoiesis and worsen anemia. No patients have high hemoglobin and erythrocyte levels. This shows that although many tuberculosis patients can maintain normal hemoglobin and erythrocyte levels, anemia remains a significant problem that needs attention. Anemia can worsen the patient's condition due to inadequate tissue oxygenation, which has the potential to inhibit the healing process.

These results differ from the study conducted by Talakua et al. (2020) at Dr. M. Haulussy Ambon Regional Hospital, which showed that 67.7% of tuberculosis patients had anemia. This atypical result may be influenced by several factors specific to Bantaeng Regency, such as improved community nutritional awareness, availability of local food rich in iron, and access to public health programs supporting supplementation or early intervention. Moreover, the selection of patients based on the hospital database might include patients in early TB stages or those already undergoing treatment, potentially leading to hematological improvement.

This difference can be caused by several factors, including differences in population, level of health awareness, and access to nutritious food. In Bantaeng Regency, public awareness of maintaining a healthy diet and consuming supplements that support hemoglobin levels seems to be higher. This is supported by a clean environment and healthy living habits that are starting to be implemented by the community.

Patients with low hemoglobin and erythrocyte levels are often associated with poor nutritional conditions. Lack of consumption of iron-rich foods such as green vegetables, red meat, and fruits can worsen anemia in tuberculosis patients. In addition, side effects of anti-tuberculosis drugs such as nausea can reduce appetite, thereby worsening the patient's nutritional intake. This condition shows the importance of nutritional intervention in supporting tuberculosis treatment.

Lifestyle factors also play an important role in determining hemoglobin and erythrocyte levels in tuberculosis patients. Habits such as smoking, alcohol consumption, and staying up late can affect the hematological health of patients. Smoking, for example, has been known to reduce the oxygen-carrying capacity of hemoglobin, while alcohol can affect erythrocyte production in the bone marrow. These factors require special attention in the management of tuberculosis patients. However, these variables were not directly measured in this study and should be included in future research. (Mursalim et al., 2022).

The side effects of anti-tuberculosis drugs such as isoniazid and pyrazinamide are also important factors that affect hemoglobin and erythrocyte levels. These drugs can cause digestive disorders, nausea, and vomiting, which ultimately affect the patient's food intake. In addition, some drugs can cause hemolytic anemia or impaired erythrocyte production in the bone marrow, which worsens the patient's condition.

High levels of anemia in tuberculosis patients can affect the success of treatment. Studies have shown that patients with low hemoglobin levels tend to have a slower recovery rate than patients with normal hemoglobin levels. This is due to the lack of sufficient oxygen to support the metabolic process and regeneration of tissue damaged by infection.

Nutritional interventions such as iron and vitamin B12 supplementation can help increase hemoglobin and erythrocyte levels in tuberculosis patients. Nevertheless, iron supplementation should be applied cautiously, especially in TB patients, because excess iron may facilitate Mycobacterium tuberculosis growth if not balanced with adequate anti-TB therapy (Ganguly et al., 2018). However, these interventions should be done with caution, because excessive iron supplementation can worsen the infection by increasing the availability of iron for bacterial growth. Therefore, these interventions should be combined with adequate anti-tuberculosis treatment.

In addition to nutritional interventions, patient education about the importance of a healthy diet and a healthy lifestyle is essential. Patients should be informed about what

foods can increase hemoglobin and erythrocyte levels, and how to avoid habits that can worsen their condition. It is also important to pay attention to regular examination of hemoglobin and erythrocyte levels in tuberculosis patients, especially during the treatment period. This monitoring can help medical personnel detect complications of anemia early, so that intervention can be carried out in a timely manner. It also helps in evaluating the effectiveness of anti-tuberculosis treatment. Community-based anemia monitoring programs and nutritional screening strategies should be implemented as public health policies, particularly in areas with a high TB burden.

Overall, the results of this study indicate that hemoglobin and erythrocyte levels in pulmonary tuberculosis patients at Prof. Dr. HM Anwar Makkatutu Regional Hospital, Bantaeng Regency are mostly in the normal category. However, the high proportion of patients with low levels emphasizes the need for a holistic approach in tuberculosis management. A combination of medical treatment, nutritional intervention, and patient education can help reduce the impact of anemia in tuberculosis patients. These findings can inform the development of context-specific health intervention programs focusing on elderly TB patients, those with comorbidities, and those in vulnerable socioeconomic conditions.

This study provides important insights into the hematological profile of tuberculosis patients in the region. These data can be used as a basis for developing more targeted intervention programs, especially for the elderly and adults who are at high risk. With a comprehensive approach, it is hoped that the cure rate of tuberculosis patients can be increased, while reducing anemia complications.

Conclusion

Based on the results of the study on the description of hemoglobin and erythrocyte levels in inpatients with tuberculosis at Prof. Dr. HM Anwar Makkatutu Regional Hospital, Bantaeng Regency, it was found that out of 250 samples of pulmonary tuberculosis patients, it showed that patients with predominantly normal hemoglobin and erythrocyte levels were 155 (62%) people, while patients with low hemoglobin and erythrocyte levels were 95 (38%) people.

These findings indicate that although most TB patients in this study maintained normal hemoglobin and erythrocyte levels, anemia remains a significant health concern in approximately one-third of patients, particularly among elderly groups and those with possible nutritional deficiencies. This study highlights the importance of routine hematological monitoring in TB patients, especially during the treatment period, to detect and manage anemia early. In addition, this study provides practical implications for health services in implementing nutritional screening programs, public education on iron-rich diets, and community-based anemia monitoring. Future research is recommended to explore other contributing factors, such as nutritional status, drug regimen, treatment duration, comorbidities, and lifestyle factors (smoking, alcohol consumption), to obtain a more comprehensive understanding of the factors influencing hemoglobin and erythrocyte levels in TB patients. The results of this study can serve as a reference for hospitals and local health authorities in developing more targeted and context-specific intervention strategies to support TB patient recovery, improve treatment outcomes, and minimize anemia-related complications.

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Conflicts of Interest

The authors declare no conflict of interest.

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