

THE RELATIONSHIP BETWEEN HEMOGLOBIN LEVELS AND RANDOM BLOOD GLUCOSE LEVELS IN PATIENTS WITH TUBERCULOSIS DURING THE INTENSIVE TREATMENT PHASE

Revalina Putri Amelysa, Eka Nur So'emah, Arum Dwi Ningsih

Universitas Bina Sehat PPNI Mojokerto, Indonesia

Corresponding Author: @revalinaputriamelysa@gmail.com

ABSTRACT

Tuberculosis (TB) can cause disturbance hematological and metabolic, including decline hemoglobin (Hb) levels and improvement Random Blood Glucose levels (RBG). This study aims to analyze the relationship between Hb levels and RBG in intensive phase TB patients. The study used a quantitative correlational design with a retrospective approach to 70 patients selected using a total sampling technique based on medical record data. Data analysis was performed using the Pearson correlation test and simple linear regression. The average Hb level of respondents was 9.644 g/dL, while the average RBG was 195.44 mg/dL. The results showed a strong and significant negative relationship between Hb levels and RBG ($r = -0.764$; $p < 0.001$), with Hb levels explaining 58.4% of the variation in RBG ($R^2 = 0.584$). The lower the Hb level, the higher the RBG in intensive phase TB patients. Regular monitoring of Hb levels and RBG can support the evaluation of clinical conditions and patient management during the intensive phase of treatment.

Keywords: Hemoglobin, Random Blood Glucose, Tuberculosis, Intensive Phase

INTRODUCTION

Tuberculosis (TB) remains a major public health problem with a high burden of disease in various countries, including Indonesia. In addition to causing respiratory disorders, *Mycobacterium tuberculosis infection* also has systemic effects that affect the patient's hematological and metabolic conditions (Muzamil et al., 2025). The chronic inflammatory response caused by TB infection can disrupt erythropoiesis, thereby reducing hemoglobin (Hb) levels and triggering anemia of chronic disease. Concurrently, activation of proinflammatory cytokines and increased stress hormones can lead to impaired glucose metabolism, characterized by increased blood glucose levels (Rahman et al., 2022). These conditions have the potential to worsen the patient's clinical status and affect treatment success (Awalia et al., 2024).

The intensive phase is the initial stage of TB treatment, aimed at rapidly reducing the bacterial load through the administration of a combination of antituberculosis drugs. Although therapy has begun, inflammation and tissue repair are still ongoing, resulting in changes in hematological and metabolic parameters (Mohammadnabi et al., 2024). Decreased Hb levels during this phase can reduce oxygen-carrying capacity and hinder recovery, while increased RBG can impair immune function, delay healing, and increase the risk of complications and therapy failure (Mustopa et al., 2023).

Several studies have reported changes in hemoglobin and blood sugar levels in TB patients during treatment. However, studies specifically evaluating the relationship between these two parameters during the intensive phase are limited and have yielded varying results (Mar'iyah & Zulkarnain, 2021). Most studies focus on changes in each parameter separately or compare conditions before and after therapy. Therefore, information on the relationship

between hemoglobin and blood glucose during the intensive phase is limited (Byers & Guy, 2024) .

Understanding the relationship between Hb levels and RBS (Random Blood Glucose) during the intensive phase has important clinical value because it can serve as the basis for comprehensive patient monitoring (Susilawati et al., 2023) . Early identification of changes in these two parameters is expected to assist healthcare professionals in detecting hematological and metabolic disorders, evaluating therapeutic response, and developing more appropriate interventions to improve TB treatment success (Come et al., 2023) .

Based on this description, this study aims to analyze the relationship between hemoglobin levels and random blood glucose levels in tuberculosis patients undergoing the intensive phase of treatment. The results are expected to provide additional scientific evidence regarding the relationship between hematological and metabolic status in TB patients and serve as a consideration in clinical monitoring during the intensive phase of therapy.

METHOD

This quantitative study, with a correlational analytical design, used a retrospective approach to analyze the relationship between hemoglobin (Hb) levels and Random Blood Glucose (RBG) levels in patients with tuberculosis (TB) in the intensive phase. This retrospective approach was chosen because the study utilized data documented in medical records without providing intervention to the subjects.

The study was conducted at the Pacet Community Health Center (Puskesmas Pacet) in Mojokerto Regency, using patient medical records from 2024–2025. The study population consisted of all TB patients undergoing the intensive phase of treatment during that period. A sample of 70 patients was selected using a total sampling technique.

The independent variable in this study was Hemoglobin (Hb) levels, while the dependent variable was Random Blood Glucose (RBG). Data were obtained from medical records and documented laboratory test results, including baseline patient characteristics, Hb values, and RBG values. All patient identities were anonymized to maintain data confidentiality.

Data analysis was performed univariately to describe the characteristics of respondents and the distribution of Hb and RBG values using the mean, standard deviation, frequency, and percentage. Bivariate analysis used the Pearson correlation test to assess the relationship between Hb levels and RBG because both variables are ratio scaled and meet the assumptions of parametric analysis. In addition, a simple linear regression analysis was performed to identify the contribution of Hb levels to variations in RBG levels. All analyses were performed using SPSS software with a statistical significance level set at $p < 0.05$.

The research has obtained ethical approval from the Institute for Research and Community Service (LPPM) of Bina Sehat University PPNI Mojokerto. The research permit was issued by Bina Sehat University PPNI Mojokerto with letter number No. IV.a/083/SP-Fikes/02/2026) and approved by the UPTD Puskesmas Pacet Mojokerto as the research site with letter number No. 440/66.A/416-102.23/2026). During the research process, the researcher applied the principles of confidentiality , anonymity , and non -*maleficence* through the use of secondary data and patient identity encoding so that the entire research

process has fulfilled the principles of research ethics, including respect for respondents' rights and the confidentiality of respondents' identities and data.

FINDING AND DISCUSSION

RESEARCH RESULT

Table 1 Distribution Frequency Respondents Based on Gender, Age , Last Education , Length of Suffering from Pulmonary TB, History of Hereditary Disease , and Employment Status

No	Respondent Characteristics	n	%
Gender			
1	Man	40	57.1
2	Woman	30	42.9
Age			
1	< 40 Years	39	55.7
2	40-60 Years	21	30.0
3	> 60 Years	10	14.3
Last education			
1	Elementary School	12	17.1
2	Junior High School	3	4.3
3	Senior High School	45	64.3
4	College	10	14.3
Long-term Suffering from Pulmonary TB			
1	< 6 Months	70	100.0
2	6-12 Months	0	0
3	> 12 Months	0	0
History of Hereditary Diseases			
1	There is	22	31.4
2	There isn't any	48	68.6
Employment Status			
1	Work	55	78.6
2	Doesn't work	15	21.4

Source : Secondary Data from UPTD Puskesmas Pacet 2024-2025

A total of 70 patients tuberculosis (TB) phase intensive included in study this . Based on characteristics respondents , the majority various sex male (57.1%), aged <40 years (55.7%), have level high school education (64.3%), no own history disease descent (68.6%), and status working (78.6%). All respondents were patients who had suffered from TB for less than 6 months (100%).

Table 2 Data Normality Test

Test of Normality			
	Kolmogorov – Smirnov ^a		
	Statistics	df	Sig.
Intensive Phase Hemoglobin Levels	,073	70	,200*
Blood Sugar Levels During the Intensive Phase	,078	70	,200*

Source : IBM SPSS Statistics

Before done analysis relationship , data tested normality and shows normal distribution ($p>0.05$), so that fulfil assumptions For parametric tests were performed use Pearson correlation .

Table 3 Pearson Product Moment Correlation

		Blood Sugar Levels During the Intensive Phase
Intensive Phase Hemoglobin Levels	Pearson Correlation (r)	-,764
	Sig. (2-tailed) (p)	,000
	N	70

Source : IBM SPSS Statistics

Analysis results Pearson correlation shows that there is significant relationship between hemoglobin levels phase intensity and blood sugar levels when phase intensive care in pulmonary tuberculosis patients . The coefficient value correlation obtained of -0.764 with mark significance of 0.000 (<0.05). The results indicates existence correlation negative with strong power , so that show that improvement blood sugar levels during the phase intensive tend accompanied by with decline hemoglobin levels.

Table 4 Analysis Linear Regression

Table 4 Analysis Linear Regression

Model Summary						
Model		R	R Square		Adjusted R Square	Standard Error of the Estimate
1		,764 ^a	,584		,578	18,066
ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	31120,488	1	31120,488	95,355	,000 ^b
	Residual	22192,784	68	326,362		
	Total	53313,271	69			
Coefficients ^a						
Model		Unstandardized Coefficient		Standardized Coefficient	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	331,480	14,097		23,513	,000
	Intensive Phase Hemoglobin Levels	-14,105	1,444	-,764	-9,765	,000

Source : IBM SPSS Statistics

Simple linear regression analysis showed that the constructed regression model was statistically significant ($F = 95.355$; $p < 0.001$), making it suitable for explaining the relationship between hemoglobin (Hb) levels and Random Blood Glucose levels (RBG) in intensive phase tuberculosis patients. The coefficient of determination (R^2) value of 0.584 indicated that Hb levels were able to explain 58.4% of the variation in RBG, while the remaining 41.6% was influenced by other factors outside the research model. The regression equation obtained was $RBG = 331.480 - 14.105 (\text{Hemoglobin})$. The Hb regression coefficient was negative and significant ($B = -14.105$; $t = -9.765$; $p < 0.001$), indicating that every 1 g/dL increase in Hb levels was estimated to be followed by a decrease in RBG levels of 14.105 mg/dL. These findings indicate an inverse relationship between Hb levels and RBG in patients with intensive phase tuberculosis.

DISCUSSION

The results of the study showed a strong and significant negative relationship between hemoglobin (Hb) levels and Random Blood Glucose (RBG) levels in tuberculosis (TB) patients in the intensive phase ($r = -0.764$; $p < 0.001$). Simple linear regression analysis also showed that Hb levels contributed 58.4% to RBG variation ($R^2 = 0.584$), with a statistically significant regression model. These findings indicate that the lower the Hb level, the higher the RBG level in patients undergoing the intensive phase of TB treatment.

This relationship can be explained by the pathophysiological mechanisms of TB infection, which trigger a systemic inflammatory response. Activation of proinflammatory cytokines, such as interleukin-6 (IL-6) and tumor necrosis factor- α (TNF- α), can inhibit erythropoiesis, disrupt iron metabolism, and reduce erythrocyte production, leading to anemia of chronic disease (Cercamondi et al., 2021). Concurrently, the inflammatory response and metabolic stress increase the release of counterinsulin hormones, stimulate gluconeogenesis, and decrease insulin sensitivity, contributing to increased blood glucose levels (Damtie et al., 2025). Consequently, patients with lower Hb levels tend to have higher RBG levels. In addition to the inflammatory process, the use of antituberculosis drugs such as isoniazid and rifampicin can also affect hemoglobin levels through changes in erythrocytes and contribute to impaired glucose metabolism (Pongsimpin et al., 2024).

The findings of this study align with several previous studies (Muzamil et al., 2025) which reported that active TB infection is often accompanied by anemia and impaired glucose homeostasis due to chronic inflammation. Hyperglycemia in TB patients is known to reduce the effectiveness of cellular immune responses, inhibit macrophage activity, and slow the elimination of *Mycobacterium tuberculosis*. Conversely, low Hb levels can reduce the capacity to transport oxygen to tissues, thereby worsening the patient's clinical condition and recovery process. These conditions indicate that hematological and metabolic changes in TB patients are interrelated and can affect the course of the disease and response to therapy.

In addition, (Byers & Guy, 2024) as well as (Elsa et al., 2025) explain that hyperglycemia can lower effectiveness response immunity and slows down the healing process, while anemia reduces capacity transportation oxygen to network so that make things worse condition clinical patient. Combination second condition the potential influence response to therapy and outcomes treatment of TB patients.

The large coefficient of determination (58.4%) indicates that Hb levels have a significant contribution to RBG variation, although there is still 41.6% of the variation

influenced by other factors not analyzed in this study. These factors can include nutritional status, severity of infection, comorbidities such as diabetes mellitus, medication use, and individual inflammatory conditions. This finding supports the opinion (Come et al., 2023) and (Susilawati et al., 2023) that the clinical condition of TB patients is influenced by various interacting factors, so that laboratory evaluation cannot focus on only one parameter.

The clinical implication of this study is the importance of regularly monitoring Hb and RBG levels during the intensive phase of TB treatment. Examination of these two parameters can help healthcare professionals identify hematological and metabolic disorders early, allowing appropriate interventions to support successful therapy and prevent complications in tuberculosis patients (Mustopa et al., 2023).

CONCLUSION

This study demonstrates a strong and significant negative correlation between hemoglobin (Hb) levels and Random Blood Glucose (RBG) levels in tuberculosis (TB) patients undergoing the intensive phase of treatment. The lower the Hb level, the higher the measured RBG level, indicating a close relationship between hematological and metabolic changes during the early phase of TB therapy. Simple linear regression analysis also indicates that Hb levels significantly contribute to variations in RBG, although some of these variations are still influenced by factors outside the research model.

These findings reinforce the importance of a multidimensional approach in monitoring TB patients in the intensive phase, where evaluation focuses not only on the clinical response to antituberculosis therapy but also includes simultaneous monitoring of hematological and metabolic parameters (Rosidah et al., 2024). Integrating Hb and RBG examinations into clinical practice has the potential to support early detection of systemic disorders, assist in a more comprehensive assessment of patient conditions, and serve as a basis for clinical decision-making to optimize management during the intensive phase of treatment (Yanqiu et al., 2024).

Further research is recommended to involve a prospective design with a wider population coverage and consider confounding factors, such as nutritional status, comorbid diabetes mellitus, body mass index, and disease severity, so that the mechanism of the relationship between Hb levels and RBG in tuberculosis patients can be understood more comprehensively.

REFERENCES

- Awalia, R., Ridwan, A., & Islawati. (2024). Description of blood sugar levels in tuberculosis (TB) patients at H. Andi Sultan Daeng Radja Regional Hospital, Bulukumba Regency. *Journal of Health Medicine*, 5 (2), 77–86. <https://doi.org/10.59963>
- Byers, M., & Guy, E. (2024). The complex relationship between tuberculosis and hyperglycemia. *Diagnostics*, 14 (22), 2359(1-12). <https://doi.org/https://doi.org/10.3390/diagnostics14222539>
- Cercamondi, C.I., Stoffel, N.U., Moretti, D., Zoller, T., Swinkels, D.W., Zeder, C., Mhimibra, F., Hella, J., Fenner, L., & Zimmermann, M.B. (2021). Iron homeostasis during anemia of inflammation: a prospective study of patients with tuberculosis. *Blood*, 138 (15), 1293–1303. <https://doi.org/10.1182/blood.2020010562>
- Come, YFR, Buntoro, IF, Setiono, KW, & Setianingrum, ELS (2023). *The Effect of Intensive*

Phase of Anti Tuberculosis Drugs With Hemoglobin Levels in Tuberculosis Patients in Kupang City . 11 . <https://doi.org/https://doi.org/10.35508/cmj.v11i1.10515>

- Damtie, S., Legese, B., Fentie, A., Solomon, Y., Erki hun, M., Molla, T., Almaw, A., Kiros, T., & Wondmagegn, M. (2025). Diabetes mellitus and its determinants among tuberculosis patients in south gondar zone health facilities , northwest ethiopia. *Scientific Reports* , 15 (5813), 1–10. <https://doi.org/https://doi.org/10.1038/s41598-025-90441-1>
- Elsa, A., Antoro, B., & Sari, NN (2025). Factors associated with the incidence of increased blood sugar levels in tuberculosis (TB) patients. *Journal of Qualitative Health Research & Case Studies Report* , 5 (4), 564–572. <https://doi.org/https://doi.org/10.56922/quilt.v5i4.1512>
- Mar'iyah, K., & Zulkarnain. (2021). Pathophysiology of tuberculosis infection. *Journal of UIN Alaudin Makassar* , November , 88–92. <https://doi.org/http://journal.uin-alauddin.ac.id/index.php/psb>
- Mohammadnabi, N., Shamseddin, J., Emadi, M., Bodaghi, A.B., Varseh, M., Shariati, A., Rezaei, M., Dastranj, M., & Farahani, A. (2024). Mycobacterium tuberculosis : the mechanisms of pathogenicity, immune responses, and diagnostic challenges. *Journal of Clinical Laboratory Analysis* , 38 (23), 1–16. <https://doi.org/10.1002/jcla.25122>
- Mustopa, R., Syarthibi, A., & Tamrin. (2023). Significance of anemia incidence based on interpretation of erythrocyte index values in pulmonary tuberculosis patients. *Journal of Medical Laboratory and Science (JMLS)* , 3 (2), 60–66. <https://doi.org/10.36086/medlabscience.v3i2>
- Muzamil, H., RY, & Kusyairi, A. (2025). The relationship between blood sugar levels in TB (DM) patients and the positive level of MTB (Mycobacterium tuberculosis) based on the results of the TCM (Molecular Rapid Test) at the Maron Community Health Center. *Health Research Journal* , 3 (2), 54–62. <https://ejournal.dpdppnikabprobolingo.org/index.php/health-research-journal/article/view/91>
- Pongsimpin, I., Sunaidi, Y., & Taufiq, N. (2024). Comparison of erythrocyte indices in tuberculosis patients undergoing initial and continuation phase treatment as a risk monitoring tool for anemia. *Kendari Health Analysis Journal* , 7 (1), 22–29. <https://doi.org/http://dx.doi.org/10.46356/jakk.v7i1.335>
- Rahman, S., Pulungan, AL, & Bojang, KS (2022). The impact of blood glucose levels on acid-fast bacteria conversion in tuberculosis patients with diabetes mellitus. *Magna Medika* , 9 (August), 120–127. <https://doi.org/10.26714/magnamed.9.2.2022.120-127>
- Rosidah, U., Auliya, QA, Wikandari, RJ, & Widiyanto, SYD (2024). *Risk Factors for Anemia in Pulmonary Tuberculosis Patients in the Treatment Phase . 06* (02), 156–164.
- Susilawati, NM, Yudhaswara, NA, & Octrisdey, K. (2023). The effect of treatment duration on blood profiles in pulmonary tuberculosis patients at the Oesapa Community Health Center. *Ventilator Journal: Journal of Health and Nursing Research* , 1 (4), 205–216. <https://doi.org/https://doi.org/10.59680/ventilator.v1i4.706>
- Yanqiu, X., Yang, Y., Xiaoqing, W., Zhixuan, L., Kuan, Z., Impact of hyperglycemia on tuberculosis treatment outcomes: a cohort study. *Scientific Reports* , 14 (13589), 1–9. <https://doi.org/10.1038/s41598-024-64525-3>