Jurnal Kedokteran dan Kesehatan: Publikasi Ilmiah Fakultas Kedokteran Universitas Sriwijaya
Volume 13, No 2. 2026/DOI: 10.32539/JKK.V13i2.734
p-ISSN 2406-7431; e-ISSN 2614-0411
Page: 206-213

RELATIONSHIP BETWEEN BLOOD TRANSFUSION FREQUENCY AND BLOOD IRON CONCENTRATION IN PATIENT WITH THALASSEMIA MAJOR

Vanessa Ainum Rizqita[1], Tjam Diana Samara [2*]
[1] Undergraduate Medical Study Program, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia
[2]Anatomi Department, Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia

ARTICLE INFO

Corresponding author :
Tjam Diana Samara
Faculty of Medicine,
Universitas Trisakti

Email:
dianasamara@trisakti.ac.id

Kata kunci:
Frekuensi
Transfusi darah
Kadar feritin
Talasemia mayor
Anak

Keywords:
Frequency
Blood transfusion
Ferritin level
Thalassemia major
Children

Original submisson:
September 11, 2025
Accepted:
March 26, 2026
Published:
April 25, 2026

ABSTRAK

Transfusi darah rutin yang dilakukan oleh pasien talasemia mayor dapat menyebabkan akumulasi zat besi berlebih dalam tubuh, yang berisiko menimbulkan komplikasi. Kadar feritin dalam serum digunakan untuk menilai akumulasi zat besi dalam tubuh. Penelitian ini bertujuan untuk mengetahui korelasi antara frekuensi transfusi dengan akumulai zat besi pada pasien talasemia mayor. Penelitian ini menggunakan desain potong lintang dengan observasi analitik. Data dikumpulkan secara consecutive non random sampling dari rekam medis sebanyak 55 pasien talasemia mayor berusia 5-18 tahun yang menjalani transfusi darah di RS Hermina Jatinegara dari Januari hingga Desember 2023. Variabel bebas adalah frekuensi transfusi darah dalam setahun, sedangkan variabel tergantung adalah kadar rata-rata feritin dalam serum yang diukur tiga kali selama setahun (per empat bulan sekali). Data yang didapat dianalisis menggunakan uji korelasi Spearman. Hasil pada penelitian ini ditemukan frekuensi transfusi darah pasien talasemia mayor dalam satu tahun sebanyak 15 kali per tahun (berdasarkan nilai median). Rata-rata kadar ferritin dalam serum sebesar 3957,73 ng/mL. (berdasarkan nilai median). Uji korelasi Spearman menunjukkan adanya korelasi lemah antara frekuensi transfusi darah dan kadar feritin (r = 0,292; p = 0,031). Simpulan penelitian ini adalah kenaikan frekuensi transfusi darah diikuti dengan kenaikan kadar besi dalam darah namun dengan kekuatan korelasi yang lemah.

ABSTRACT

Relationship Between Blood Transfusion Frequency and Blood Iron Concentration in Patient with Thalassemia Major. Routine blood transfusions performed on thalassemia major patients can cause excessive iron accumulation in the body, which carries the risk of complications. Serum ferritin levels are used to assess body iron stores. This study aims to determine the correlation between transfusion frequency and iron accumulation in patients with thalassemia major. This study used a cross-sectional design with analytical observation. Data was collected by consecutive, non-random sampling from the medical records of 55 patients with thalassemia major aged 5-18 years who underwent blood transfusions at Hermina Jatinegara Hospital from January to December 2023. The independent variable was the frequency of blood transfusions per year, while the dependent variable was the average serum ferritin level, measured three times a year (every 4 months). The data obtained were analyzed using the Spearman correlation test. The results of this study found that the frequency of blood transfusions in thalassemia major patients over 1 year was 15 per year (based on the median). The average serum ferritin level was 3957.73 ng/mL (based on the median value). Spearman's correlation test showed a weak correlation between blood transfusion frequency and ferritin levels (r = 0.292; p = 0.031). The study concluded that increased blood transfusion frequency was associated with higher blood iron levels, but the correlation was weak.

INTRODUCTION

Thalassemia is a chronic hemoglobin (Hb) disorder inherited in an autosomal recessive pattern. It is characterized by a reduction in the synthesis of globin chains, which may involve either the α- or β-globin chains.[1] According to the type of globin chain affected, thalassemia is classified

into α-thalassemia and β-thalassemia.[2] Thalassemia is classified into three types based on its clinical manifestations. Thalassemia minor (trait) is often asymptomatic or only mildly anemic. Thalassemia intermedia is characterized by symptoms that appear later compared to thalassemia major, with patients experiencing mild to moderate anemia. Thalassemia major represents the most severe form, requiring lifelong blood transfusions, and is typically detected during infancy or early childhood.[3]

Indonesia is one of the countries located within the global thalassemia belt, characterized by a high frequency of thalassemia genes.[4] The prevalence of thalassemia carriers in Indonesia is estimated at 3–8% of the total population, with a birth rate of 23 per 1,000 among a population of approximately 240 million. According to 2021 data, there were 10,531 thalassemia patients in Indonesia, with more than 2,500 infants born each year with the condition.[5] Thalassemia major cases requiring regular blood transfusions occur predominantly among children and adolescents. The majority of patients with thalassemia major who receive blood transfusions fall within the 5–18-year age group, as transfusion requirements during this period tend to remain stable to support growth and daily activities, particularly during the phase of active development.[6]

The primary management of anemia in patients with thalassemia major is blood transfusion. The goal of transfusion therapy is to maintain hemoglobin (Hb) levels above 9–9.5 g/dL.[7] Blood transfusions are typically performed at intervals of 3–4 weeks, with the volume tailored to the patient's body weight and hemoglobin concentration.[8] Blood transfusion therapy, monitoring, and management of iron overload are of primary concern. Since the human body lacks an active mechanism for eliminating excess iron, prolonged transfusion may lead to iron accumulation.[7] Recent evidence consistently demonstrates that cumulative transfusional exposure is a major determinant of iron overload in transfusion-dependent thalassemia. Each unit of transfused red blood cells delivers approximately 200–250 mg of iron, and in the absence of a physiologic mechanism for active iron excretion, iron progressively accumulates over time.[9] Moreover, clinical cohort data have shown a statistically significant association between total transfusion burden and serum ferritin concentration in patients with transfusion-dependent β-thalassemia major, indicating that greater cumulative exposure to transfusion contributes to higher iron loading as measured by ferritin levels.[10] However, a literature review on post-transfusion ferritin levels in pediatric β-thalassemia major patients reported that mean ferritin concentrations in several analyzed studies were within recommended clinical targets. This observation indicates that ferritin levels may be maintained within acceptable limits when appropriate management strategies are implemented.[11] Serum ferritin measurement is the most commonly used method to evaluate iron accumulation (hemosiderosis) in thalassemia patients undergoing regular transfusions.[12]

The novelty of this study lies in its analytical cross-sectional approach in evaluating transfusion frequency as a quantitative variable associated with serum ferritin levels in thalassemia major patients within a specific local population. By providing updated local data, this study aims to clarify inconsistent findings reported in previous studies and to strengthen the evidence base for iron overload monitoring in routinely transfused patients.

METHOD

This study used a cross-sectional design with an analytical observational approach. The study population comprised patients with thalassemia major undergoing blood transfusions at Hermina Jatinegara Hospital, East Jakarta. Although thalassemia major consists of alpha thalassemia major dan beta thalassemia major[2], in this study they were not differentiated.

Based on the results of the sample-size calculation using the correlation test, 55 samples were obtained from 160 patients between January 1 and December 31, 2023. Sampling used the consecutive non-random sampling method. Samples were selected based on predefined inclusion and exclusion criteria. Inclusion criteria were patients with thalassemia major aged 5–18 years who had received blood transfusions and possessed complete medical records, including age, sex, annual transfusion frequency, and serial ferritin levels recorded between January and December 2023. Exclusion criteria were patients with coexisting hematological disorders, such as leukemia, hemophilia, or sickle cell anemia. Respondents were excluded if these diseases or disorders were listed in their medical records. If they were not listed, the patient was assumed not to have any other blood disorders.

Serum ferritin levels in this study were the average of three blood draws per year, performed at four-month intervals. The blood transfusion frequency in this study was the number of transfusions per year. All data were taken from medical records.

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 30. The Kolmogorov-Smirnov test was used to assess normality, as the sample size was >50. Since the data were not normally distributed, the Spearman correlation test was employed, with statistical significance set at $p < 0.05$.

RESULT

This study used medical records of patients with thalassemia major from the blood transfusion unit at Hermina Jatinegara Hospital in 2023, involving a total of 55 subjects.

Table 1. Distribution of study subject characteristics

Characteristic	Mean ± SD	Median (Range)	Frequency (n = 55)	Percentage (%)
Age	10,56 ± 3,711			
Gender				
Male			32	58,2
Female			23	41,8
Serum ferritin (ng/mL)		3957,73 (383,87 – 28566,16)		
Transfusion frequency (times/year)		15 (9 – 23)		

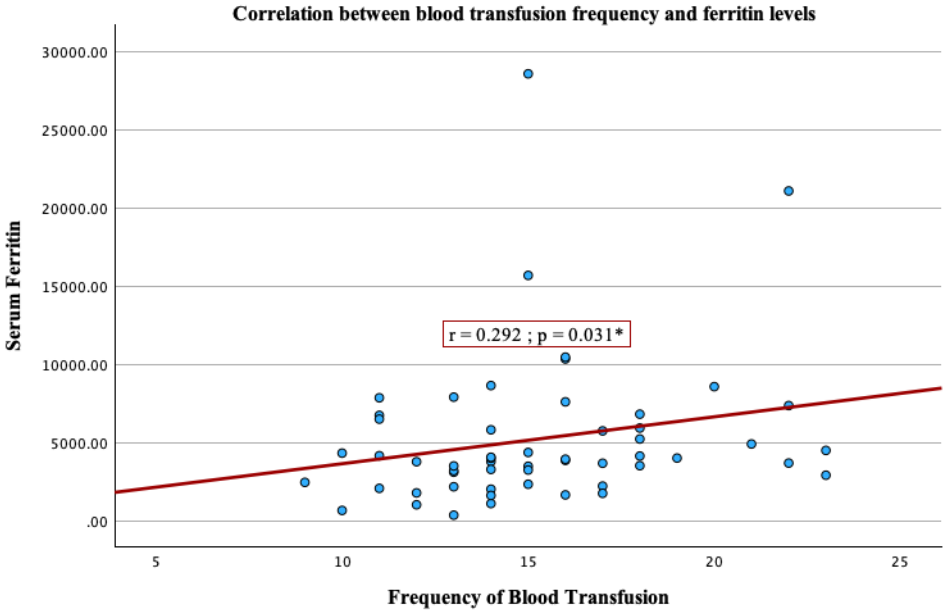
Note: Data are presented as mean ± standard deviation for normally distributed variables and median (range) for non-normally distributed variables.
SD: standard deviation

Based on Table 1, of the 55 subjects in the thalassemia blood transfusion unit, 32 (58.2%) were male, and 23 (41.8%) were female. Since the age data were normally distributed, age is presented as mean ± SD. The subjects' ages ranged from 5 to 18 years, with a mean age of 10.56 years and a standard deviation of 3.711 years.

In this study, because the data were not normally distributed, the distributions of serum ferritin levels and blood transfusion frequency were presented as medians. Based on Table 2, serum ferritin data obtained from serial measurements throughout 2023 showed 3,957.73 ng/mL

(according to a median value), with a minimum of 383.87 ng/mL and a maximum of 28,566.16 ng/m. The frequency of blood transfusions in patients with thalassemia major in 2023 was 15 times per year (median), ranging from 9 to 23. Normal serum ferritin level for children are 7-140 ng/mL.[13]

Relationship between blood transfusion frequency and iron levels in patients with thalassemia major



*: Spearman's Correlation Test

Figure 1. Correlation between blood transfusion frequency and ferritin levels

The one-sample Kolmogorov–Smirnov test yielded a p-value of <0.001, indicating that the residuals were not normally distributed. Therefore, bivariate analysis was performed using Spearman's correlation test. The results showed a weak correlation between the frequency of blood transfusions and serum ferritin levels (r = 0.292, p = 0.031).

DISCUSSION

Characteristics of the study subjects

In this study, 55 subjects were included; the majority were male (32, 58.2%). This result is in line with the findings of Bhalodiya et al., who reported that 59% of their study population were male.[10] However, the studies by Fianza et al. and Rochman et al. reported different findings, with a higher proportion of female subjects, accounting for 53.1% and 58.3%, respectively.[7,14] This variation supports the theory that thalassemia is a genetic disorder with an autosomal recessive inheritance pattern and is not related to the sex chromosomes.[15]

The age distribution in this study ranged from 5 to 18 years, with a mean of 10.56 and a standard deviation of 3.711. This finding is consistent with the study by Almahmoud et al., which demonstrated a predominance of children (2–9 years) and adolescents (10–18 years) among patients with thalassemia major.[16] The study by Nassim et al. also supports this finding, reporting an age distribution of subjects ranging from 2 to 14 years, with a mean age of 8.7 years.[17] A considerable number of thalassemia cases are detected during childhood, when children present with worsening clinical symptoms, particularly increasing pallor, and subsequently require routine blood transfusions to maintain growth and daily activities.[18]

Distribution of the results of the blood iron level and blood transfusion frequency

In this study, the median ferritin level among subjects was 3957.73 ng/mL, which is consistent with the findings of Saparizki et al., who reported that the majority of thalassemia patients had ferritin levels exceeding 2500 ng/mL. Ferritin levels above 1000 ng/mL generally indicate iron overload (hyperferritinemia).[19] The study by Kurban et al. also reported a median ferritin level of 1548 ng/mL, with a range of 161–3968 ng/mL, exceeding the recommended threshold value of 1000 ng/mL.[20] These findings suggest a substantial iron overload as a consequence of repeated blood transfusions among patients with thalassemia.[21]

This study found that patients with thalassemia major had a median annual transfusion frequency of 15 sessions. Aligning with the findings of Weiss et al., who reported a mean frequency of ≥12 transfusions per year.[22] On the other hand, Akbar et al. reported that most patients received 12 or fewer transfusions annually.[18] The frequency of blood transfusions in thalassemia patients varies depending on hemoglobin (Hb) levels and clinical condition. Transfusions are indicated when Hb levels fall below 7 g/dL in two consecutive measurements taken two weeks apart, or when Hb levels exceed 7 g/dL but are accompanied by clinical manifestations such as growth retardation, suspected bone fractures due to extramedullary hematopoiesis, and Cooley's facies.[18]

Relationship between blood transfusion frequency and iron levels in patients with thalassemia major

This study demonstrated a weak correlation between blood transfusion frequency and ferritin levels in patients with thalassemia major ($p = 0.031$; $r = 0.292$). This finding is consistent with the study by Bhalodiya et al., which reported a p-value of 0.00, indicating a significant increase in ferritin levels with rising total annual blood transfusion frequency.[10] Similarly, Rochman et al. demonstrated a significant relationship between the number of transfusions and increased ferritin levels ($p = 0.003$).[7] Thalassemia patients receiving repeated transfusions for anemia management are prone to elevated ferritin levels due to iron accumulation, as each unit of blood contains approximately 200–250 mg of iron, and the body lacks an inherent mechanism to excrete the excess.[23] The progressive accumulation of iron over time results in higher ferritin concentrations, thereby positioning transfusion frequency as a significant factor influencing iron overload.[24]

Although no studies have been identified that explicitly state the absence of a correlation between transfusion frequency and ferritin levels, Pangestika et al. reported that hemoglobin and serum ferritin levels in children with beta-thalassemia major remained within the normal range (100 ng/mL) after transfusion.[11] This finding is consistent with the study by Spasiano et al., which reported that serum ferritin levels below 500 ng/mL can be achieved safely in some transfusion-dependent thalassemia (TDT) patients, indicating that transfusion frequency does not necessarily correlate directly with ferritin elevation in certain cases.[25] Even though a positive correlation between transfusion frequency and ferritin levels is observed, this relationship is significantly influenced by other factors, notably adherence to iron chelation therapy, which can markedly lower ferritin levels.[24] In addition, ferritin levels are influenced by other factors such as inflammation, infection, liver function, and genetic variations, which can cause differences in ferritin concentrations even among patients with similar transfusion histories.[26]

CONCLUSION

In general, serum ferritin levels were higher than normal in study subjects who received more than 12 blood transfusions per year. However, the findings of this study indicate that the frequency of blood transfusions has only a weak effect on the increase in blood iron levels.

Future studies are advised to involve participants across a wider age range to gain a more comprehensive understanding of serum ferritin levels among thalassemia patients. In addition, subsequent research should address other potential determinants of ferritin levels, including variations in chelation therapy, treatment duration and compliance, nutritional status, and coexisting medical conditions.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this study.

ACKNOWLEDGMENTS

The authors are deeply grateful to Hermina Jatinegara Hospital for the permission and support provided throughout the data collection phase of this study.

REFERENCES

1. Wahidiyat P, Permono B. Hemoglobinopati dan thalassemia anak. In: Permono B, Sutaryo I, Ugrasena ID, Windastuti E, Abdulsalam M, editors. Buku ajar hematologi-onkologi anak. Jakarta: Ikatan Dokter Anak Indonesia; 2018:65-8.
2. Grentina, Wahidayat PA. Mengenal thalassemia [Internet]. Jakarta: Ikatan Dokter Anak Indonesia; 2016 [cited 2024 Apr 7]. Available from: https://www.idai.or.id/artikel/seputar-kesehatan-anak/mengenal-thalasemia
3. Rujito L, Siswandari W, Lestari DW, editors. Talasemia: genetik dasar dan pengelolaan terkini. Purwokerto: UNSOED Press; 2019:90.
4. Khikmah FA, Prijopranoto HS. Prevalensi thalasemia beta minor dengan menggunakan indeks mentzer pada pasien anemia Suku Sabu di RSUD Sabu Raijua. Journal of Ners Community. 2022;13(2):301-6. doi:10.55129/jnerscommunity.v13i2.1917
5. World Health Organization. Regional desk review of haemoglobinopathies with an emphasis on thalassaemia and accessibility and availability of safe blood and blood products as per these patients' requirement in South-East Asia under universal health coverage [Internet]. 2023 [cited 2024 Apr 30]. Available from: https://www.who.int/publications/i/item/9789290228516
6. Fianza PI, Rahmawati A, Widihastha SH, Afifah S, Ghozali M, Indrajaya A. Iron overload in transfusion-dependent Indonesian thalassemic patients. Anemia. 2021:5581831. doi:10.1155/2021/5581831
7. Rochman F, Mulyantari NK, Sutirtayasa IW. Hubungan jumlah transfusi darah dan penggunaan kelasi besi dengan kadar ferritin pada pasien talasemia. Medika Udayana. 2019;8(9):1-6
8. Lal A, Wong T, Keel S, Pagano M, Chung J, Kamdar A. The transfusion management of beta thalassemia in the United States. Transfusion. 2021;61(10):3027-39. doi:10.1111/trf.16640
9. Taher AT, Cappellini MD. How I manage transfusional iron overload in patients with thalassemia. Blood. 2021;137(6):667-75
10. Bhalodiya VR, Valiya LG, Mehta NA, Padhariya BB. Correlation of serum ferritin level in transfusion-dependant thalassemia major patients: a study at a medical college affiliated hospital in Gujarat region. Int J Contemp Pediatr. 2023;10(3):330-3. doi:10.18203/2349-

3291.ijcp20230429
11. Pangestika AD, Astuti TD, Aryani T. Literature review: gambaran kadar hemoglobin dan ferritin serum pada anak thalassemia β mayor paska transfusi [Internet]. 2022 [cited 2024 Mar 15]. Available from: http://digilib.unisayogya.ac.id/6629/1/NASKAH%20PUBLIKASI_AYU%20DWI%20PANGESTIKA_1811304020%20-%20Ayu%20Dwi%20Pangestika
12. Yusuf AK, Magdaleni AR, Karunia D. Hubungan kadar feritin serum terhadap fraksi ejeksi ventrikel kiri pada pasien thalassemia β mayor anak di RSDU Kabupaten Kediri. Jurnal Verdure. 2022;4(1):123–8.
13. University of Rochester Medical Center. Ferritin (Blood) [Internet]. URMC Health Encyclopedia; 2023 [cited 2026 Feb 24]. Available from: https://www.urmc.rochester.edu/encyclopedia/content?contenttypeid=167&contentid=ferritin_blood
14. Fianza PI, Rahmawati A, Wijaya I, Oehadian A, Prasetya D, Vidyaniati P. Gender disparities in psychological disturbances and quality of life among adolescent and adult patients with thalassemia: a review. J Multidiscip Healthc. 2024;17:1663-9. doi:10.2147/jmdh.s444592
15. Sadiq IZ, Abubakar FS, Usman HS, Abdullahi AD, Ibrahim B, Kastayal BS. Thalassemia: pathophysiology, diagnosis, and advances in treatment. Thalass Rep. 2024;14(4):81-102. doi:10.3390/thalassrep14040010
16. Almahmoud R, Hussein A, Khaja FA, Soliman AF, Dewedar H, Shareef ZA. Growth and endocrinopathies among children with β-thalassemia major treated at Dubai Thalassemia centre. BMC Pediatr. 2024;24:244. doi:10.1186/s12887-024-04670-w
17. Nassim MS, Mahmoud MA, Shady HA, Mohammed EAER. Assessment of disease knowledge gaps among beta thalassemia major patients and their caregivers. Egypt Pediatr Assoc Gaz. 2022;70:49. doi:10.1186/s43054-022-00143-w
18. Akbar TIS, Riyanti EY, Khairunnisa K, Wahyuni H. No association between frequency of blood transfusions and incompatibility of blood transfusions in thalassemia patients. J Indones Med Assoc. 2023;73(4):183-90. doi:10.47830/jinma-vol.73.4-2023-1069
19. Saparizki RS, Sumantri AF, Achmad S. Pengaruh kepatuhan minum obat kelasi besi dengan kadar ferritin pada pasien thalassemia di RSUD Al-Ihsan Bandung tahun 2021/2022. Bandung Conference Series: Medical Science. 2023;3(1):178-9. doi:10.29313/bcsms.v3i1.5824
20. Kurban LA, Almarri BK, Alshamsi MH, Abdelrahman SS, Alwahshi SG, Alhorani Q. Optimized serum ferritin prediction of iron overload in transfusion-dependent thalassemia: likelihood ratio and age-adjustment approach. Ann Saudi Med. 2023;43(2):90-6. doi:10.5144/0256-4947.2023.90
21. Sarkar K, Pramanik N, Goswami RP, Mandal PK, Chowdhury P, Jana K. Correlation of liver function test with different age and sex group and with ferritin level in thalassemia. Indian J Public Health Res Dev. 2020;11(6):452-7. doi:10.37506/ijphrd.v11i6.9819
22. Weiss M, Parisi Jun M, Sheth S. Clinical and economic burden of regularly transfused adult patients with β-thalassemia in the United States: a retrospective cohort study using payer claims. Am J Hematol. 2019;94(5):E129-32. doi:10.1002/ajh.25429
23. Shah F, Huey K, Deshpande S, Turner M, Chitnis M, Schiller E. Relationship between serum ferritin and outcomes in β-thalassemia: a systematic literature review. J Clin Med. 2022;11(15):4448. doi:10.3390/jcm11154448
24. Coates TD. Iron overload in transfusion-dependent patients. Hematology Am Soc Hematol Educ Program. 2019;2019(1):337-44. doi:10.1182/hematology.2019000036
25. Spasiano A, Meloni A, Costantini S, Quaia E, Cademartiti F, Cinque P. Setting for "normal" serum ferritin levels in patients with transfusion-dependent thalassemia: our current strategy. J

Clin Med. 2021;10(24):5985. doi:10.3390/jcm10245985
26. Mohamed YA, Morgan DS, Hussein AM, Mohamed AA. Noninvasive assessment and risk factors of liver fibrosis in pediatric patients with beta thalassemia major using transient elastography. Beni Suef Univ J Basic Appl Sci. 2022;11:114. doi:10.1186/s43088-022-00314-z