

CORRELATION ANALYSIS OF HEMOGLOBIN LEVELS AND *FATIGUE* SEVERITY IN CHRONIC KIDNEY DISEASE PATIENTS UNDERGOING HEMODIALYSIS

Della Sasi Karini, Sri Sudarsih, Arum Dwi Ningsih

Bina Sehat PPNI University, Mojokerto, Indonesia

Corresponding Author: dellasasi278@gmail.com

ABSTRACT

This study aimed to determine the relationship between hemoglobin levels and fatigue levels in chronic kidney disease (CKD) patients undergoing hemodialysis at Gatoel Hospital Mojokerto. An analytical observational design with a cross-sectional approach was employed. The population comprised 210 patients, with a sample of 68 respondents selected using consecutive sampling. Data were collected from medical records and the FACIT-Fatigue questionnaire, then analyzed using the Spearman rank test. The results revealed a significant relationship between hemoglobin levels and fatigue levels ($p = 0.000 < 0.05$) with a strong positive correlation ($r = 0.645$). A lower hemoglobin level corresponds to a lower FACIT score, indicating more severe fatigue. Hemoglobin reduction triggers tissue hypoxia, disrupting energy metabolism and leading to severe fatigue. In conclusion, hemoglobin levels strongly correlate with fatigue severity in CKD patients. Hospitals should regularly monitor hemoglobin levels and provide anemia management education to minimize prolonged fatigue.

Keywords: *Chronic Kidney Disease, Hemodialysis, Hemoglobin, Fatigue.*

INTRODUCTION

Chronic Kidney Disease (CKD) has emerged as a major global health challenge, characterized by an increasing annual mortality rate worldwide (Rosdewi et al., 2023). Progressive and irreversible loss of renal function in CKD, defined by a glomerular filtration rate (GFR) below 15 mL/min/1.73^2 , necessitates renal replacement therapy such as long-term hemodialysis to sustain patient survival (Antony et al., 2020). Although hemodialysis effectively replaces the excretory functions of the kidneys, it cannot restore endocrine impairment, particularly the inadequate secretion of erythropoietin (Rosdewi et al., 2023). Consequently, erythropoietin deficiency directly impairs erythropoiesis, giving rise to chronic anemia as one of the most prominent clinical complications in end-stage renal disease (Patimah et al., 2024).

The prevalence of anemia escalates in advanced stages of CKD, where a majority of hemodialysis patients exhibit subnormal hemoglobin levels (Wong et al., 2020). Low hemoglobin levels diminish the oxygen-carrying capacity of the blood, resulting in systemic tissue hypoxia that clinically presents as severe *fatigue* (Nurhalizah et al., 2025). *Fatigue* in hemodialysis patients is a complex, multidimensional phenomenon encompassing physical exhaustion and reduced functional capacity, which severely impairs daily independent living (Kieffer et al., 2021). Despite its profound burden on patient well-being, *fatigue* is frequently overlooked by healthcare providers and dismissed as an inevitable byproduct of routine dialysis treatment (Kieffer et al., 2021; Wong et al., 2020).

Epidemiological data highlight the urgent necessity for improved management of end-stage renal disease and its associated symptoms. The World Health Organization projects kidney disease to become the fifth leading cause of death globally by 2040, currently

accounting for approximately 1.3 million deaths annually (WHO, 2025). Globally, more than 850 million people—exceeding 10% of the world's population—are affected by kidney disease (Francis et al., 2024). In Indonesia, national surveys report a CKD prevalence of 0.18%, with 21.1% of affected individuals depending on maintenance hemodialysis (KemenKes RI, 2023; SKI, 2023). At the regional level, kidney failure ranks as the seventh leading cause of inpatient mortality in East Java, recording 4,909 deaths with a case fatality rate of 11.09% (Dinas Kesehatan Provinsi Jawa Timur, 2024). Furthermore, in Mojokerto Regency, high rates of hypertension (80,185 cases) and diabetes mellitus (36,210 cases)—the two primary etiologies of permanent renal failure—indicate a substantial population at risk of developing dialysis-related complications (Dinkes Kabupaten Mojokerto, 2024).

Prior literature confirms that *fatigue* is highly prevalent among patients undergoing maintenance hemodialysis. Saraswati and Lestari (2024) observed that 63.3% of hemodialysis patients suffered from severe *fatigue*, while Nugrahandari et al. (2024) reported that 67.4% experienced moderate *fatigue* and 32.6% faced severe *fatigue*. Patimah et al. (2024) demonstrated that 61.5% of hemodialysis patients had low hemoglobin levels and identified an 11-fold increase in *fatigue* risk among anemic patients compared to non-anemic counterparts. However, existing studies often focus broadly on general *fatigue* predictors or quality-of-life parameters without isolated investigation into how specific variations in hemoglobin concentrations quantitatively correlate with *fatigue* severity levels measured by validated clinical tools like the FACIT-*Fatigue* scale in local hospital settings (Nugrahandari et al., 2024; Saraswati & Lestari, 2024). A preliminary study conducted on April 13, 2026, at the Hemodialysis Unit of Gatoel Hospital Mojokerto revealed that among 210 active patients, initial interviews with representative patients showed persistent post-dialytic *fatigue* alongside low hemoglobin levels ranging from 6.2 to 8.3 g/dL.

This study aimed to analyze the relationship between hemoglobin levels and fatigue severity among CKD patients undergoing hemodialysis at Gatoel Hospital Mojokerto to address this empirical gap. Specifically, this study answers the core research question: Is there a significant relationship between hemoglobin levels and *fatigue* severity among CKD patients undergoing routine hemodialysis at Gatoel Hospital Mojokerto?

This study offers a valuable contribution to the clinical management of chronic kidney disease by establishing localized empirical evidence on the physiological linkage between anemia severity and *fatigue* burden. By utilizing the standardized FACIT-*Fatigue* assessment tool alongside precise medical record hemoglobin data, the findings provide actionable insights for nursing practice and nephrology care teams. Systematically incorporating hemoglobin monitoring as a predictive indicator for *fatigue* enables healthcare providers to implement early targeted anemia interventions, thereby mitigating *fatigue*-related disability and optimizing the overall quality of life for long-term dialysis patients (Kim et al., 2025; Qawasmeh et al., 2025).

METHOD

This study utilized a quantitative approach with an analytical observational design and a cross-sectional method, wherein both independent and dependent variables were measured simultaneously (Hardani et al., 2020). The research was conducted at the Hemodialysis Unit of Gatoel Hospital Mojokerto from February to June 2026, with primary data collection occurring over three consecutive days from May 4 to May 6, 2026.

The target population comprised 210 chronic kidney disease (CKD) patients undergoing routine hemodialysis (Hardani et al., 2020). A sample of 68 respondents was selected using a non-probability consecutive sampling technique, calculated based on Slovin's formula with a 10% margin of error (Amruddin et al., 2022). Inclusion criteria mandated patients aged 18–55 years who had been undergoing hemodialysis twice weekly for at least three months, were fully conscious (*compos mentis*), and provided informed consent. Conversely, patients experiencing sudden medical emergencies, cognitive impairments, or those undergoing once-weekly dialysis were excluded.

Data collection involved two primary variables. The independent variable, hemoglobin levels, was measured objectively using secondary data from recent complete blood count (CBC) medical records based on clinical practice guidelines (KDIGO, 2026). The dependent variable, *fatigue* severity, was assessed subjectively during the pre-hemodialysis phase using the Functional Assessment of Chronic Illness Therapy (FACIT)-*Fatigue* scale version 4, a 13-item questionnaire.

Following data processing steps of editing, coding, scoring, entry, and cleaning, statistical analysis was performed (Hardani et al., 2020). Univariate analysis was used to describe respondent characteristics and variable frequencies, while bivariate analysis was conducted using the non-parametric Spearman-Rank correlation test with a significance level of $\alpha = 0.05$ to evaluate the relationship and correlation strength between hemoglobin levels and *fatigue* severity (Amruddin et al., 2022). The study protocol was ethically approved by the Research Ethics Committee of Bina Sehat PPNI Mojokerto University under Approval No. 140/KEP/UBS-PPNI/V/2026.

FINDING AND DISCUSSION

RESEARCH RESULT

The data collection was conducted from May 4 to May 6, 2026, at the Hemodialysis Unit of Gatoel Hospital Mojokerto, involving a total of 68 respondents suffering from Chronic Kidney Disease (CKD) who were undergoing routine hemodialysis treatment. The primary findings are categorized into respondent demographic characteristics, univariate distributions of study variables, and bivariate analysis results.

Respondent Characteristicts

Table 1 outlines the demographic profile of the respondents, including age, gender, educational level, employment status, and hemodialysis duration

Table 1: Characteristicts of Chronic Kidney Disease Patients Undergoing Hemodialysis

Characteristicts Category	Frequency (<i>f</i>)	Percent (%)
Age		
26-35 Tahun (Early Adult)	7	10,3
36-45 Tahun (Late Adult)	12	17,6
46-55 Tahun (Early Ederly)	49	72,1
Gender		
Male	37	54,4
Female	31	45,6

Education Level		
Elementary School/Equivalent	5	7,4
Junior High School/Equivalent	12	17,6
Senior High School/Equivalent	34	50,0
Higher Education/Bachelor	17	25,0
Employment Status		
Employed	15	22,1
Unemployed	53	77,9
HD Duration		
3-12 Months	12	17,6
>12 Months	56	82,4
Total	68	100

Source: Primary Data Analysis (2026)

As shown in Table 1, the majority of respondents were aged 46–55 years (72.1%), male (54.4%), had completed senior high school education (50.0%), were unemployed (77.9%), and had undergone hemodialysis for more than 12 months (82.4%).

Hemoglobin Levels and *Fatigue* Severity Distribution

The univariate distribution for the two primary variables—hemoglobin level and fatigue severity—is presented in Table 2 and Table 3.

Table 2: Frequency Distribution of Hemoglobin Levels

Hemoglobin Level Category	Frequency (f)	Percent (%)
9,9-10,0 g/dL (Mild Anemia)	8	11,8
8,0-9,9 g/dL (Moderate Anemia)	26	38,2
<8,0 g/dL (Severe Anemia)	34	50,0
Total	68	100

Source: Primary Data Analysis (2026)

Based on Table 2, half of the respondents suffered from severe anemia (50.0%), followed by moderate anemia (38.2%), and mild anemia (11.8%).

Table 3: Frequency of *Fatigue* Severity

<i>Fatigue</i> Category	Frequency (f)	Percent (%)
<i>Mild Fatigue</i> >30	19	27,9
<i>Severe Fatigue</i> ≤30	49	72,1
Total	68	100

Source: Primary Data Analysis (2026)

Table 3 indicates that a predominant portion of respondents experienced severe *fatigue* (72.1%), whereas 27.9% presented with mild *fatigue*.

Relationship Between Hemoglobin Levels and Fatigue Severity

Table 4 displays the cross-tabulation and bivariate analysis between hemoglobin levels and *fatigue* severity among hemodialysis patients.

Table 4: Crosstabulation of Hemoglobin Levels and *Fatigue* Severity

Hemoglobin Level Category	Fatigue				Total	
	Mild		Severe			
	N	%	N	%	N	%
9,9-10,0 g/dL (Anemia Ringan)	8	100	0	0,0	8	100
8,0-9,9 g/dL (Anemia Sedang)	9	34,6	17	65,4	26	100
<8,00 g/dL (Anemia Berat)	2	5.9	32	94,1	34	100
Total	19	27	49	72,1	68	100
p-value = 0,000: Spearman rho = 0,645						

Source: Primary Data Analysis (2026)

As highlighted in Table 4, 32 out of 34 respondents with severe anemia (94.1%) suffered from severe *fatigue*. Statistical testing using the *Spearman-Rank* correlation test yielded a *p-value* of 0.000 ($p < 0.05$) and a correlation coefficient (*r*) of 0.645

DISCUSSION

The results of this study revealed that the majority of Chronic Kidney Disease (CKD) patients undergoing hemodialysis at Gatoel Hospital Mojokerto experienced severe anemia, accounting for 34 respondents (50.0%), whereas mild anemia represented the smallest proportion (11.8%). The high prevalence of severe anemia in this population is primarily driven by reduced production of erythropoietin (EPO) due to renal parenchymal damage, chronic systemic inflammation (inflammaging), shortened erythrocyte lifespan, and disrupted iron metabolism (KDIGO, 2026). The hemodialysis procedure itself further exacerbates hemoglobin reduction through iatrogenic blood loss within the extracorporeal circuit, oxidative stress-induced hemolysis, and routine anticoagulant use (Abdijalil, 2023).

A striking phenomenon was observed among patients with a dialysis duration of 3–12 months, where 58.3% suffered from severe anemia, underscoring that the early phase of therapy represents a critical transition period (vulnerable period). During this adaptation phase, unstable uremic syndromes trigger gastrointestinal disturbances such as nausea and anorexia, leading to malnutrition and essential iron deficiency (Salsabila et al., 2025). Meanwhile, among patients on long-term therapy (>12 months), the high rate of severe anemia (79.4%) is attributed to cumulative chronic inflammation and bone marrow exhaustion (Mardiyah et al., 2026). Demographic analysis indicated that severe anemia was predominantly concentrated in the 46–55 age group (76.5%) due to age-related renal decline (renal aging) that impairs hematopoietic function (Santos et al., 2025), as well as among female patients (61.3%) owing to lower iron stores and hormonal influences (Su et al., 2023).

Consistent with the hemoglobin findings, the majority of respondents also experienced severe *fatigue*, totaling 49 patients (72.1%), whereas mild *fatigue* was reported by only 27.9% of respondents. Newly admitted patients with a dialysis duration of 3–12 months recorded a remarkably high proportion of severe *fatigue*, reaching 91.7%. This is

attributed to the body's inability to abruptly compensate for massive fluid shifts, intradialytic blood pressure fluctuations, and unadapted psychological coping mechanisms (Zhu et al., 2023).

Among patients with a dialysis duration of >12 months, severe *fatigue* (67.9%) was more strongly influenced by the cumulative impact of chronic inflammation and progressive nutritional depletion (Mardiyah et al., 2026). Aside from dialysis vintage, severe *fatigue* was also concentrated among females (53.1%) and those aged 46–55 years (73.5%). Female patients are more vulnerable to severe *fatigue* due to a combination of lower hemoglobin levels, hormonal fluctuations, and complex social role burdens (Lerma et al., 2021). Meanwhile, in late adulthood, reduced physiological energy reserve capacity and uremic toxin accumulation accelerate persistent physical and functional exhaustion (Rafiullah et al., 2023).

Statistical analysis demonstrated a strong, significant, and positive correlation between hemoglobin levels and *fatigue* severity among CKD patients undergoing hemodialysis at Gatoel Hospital Mojokerto ($p = 0.000$, $r = 0.645$). This finding indicates that lower hemoglobin levels directly correspond to higher *fatigue* severity. Physiologically, hemoglobin reduction triggers systemic tissue hypoxia that impairs cellular energy metabolism and cellular ATP synthesis, thereby manifesting as persistent physical and functional *fatigue*. This condition aligns with previous studies by Kartika & Hayati (2024), Laksmana & Indriyawati (2022), and Wang et al. (2022), which identified chronic anemia as a primary predictor of post-dialysis *fatigue* severity. Furthermore, the heightened vulnerability observed during the initial 3–12 months of therapy echoes Salsabila et al. (2025) and Zhu et al. (2023), who emphasized that the early adaptation period involves uncompensated fluid shifts, uremic symptoms, and nutritional deficiencies that exacerbate *fatigue*. Similarly, the long-term cumulative effects of systemic inflammation and iron depletion observed in patients on dialysis for >12 months correspond with the findings of Mardiyah et al. (2026). Nevertheless, anomalous cases where a minority of severely anemic patients reported only mild *fatigue* demonstrate that *fatigue* is multidimensional, wherein younger age, high health literacy, and unemployed status serve as protective buffers through cardiovascular compensation and adaptive coping strategies (Mailani et al., 2025; Sharma et al., 2025).

Limitations of this study include its cross-sectional design and reliance on the self-reported FACIT-*Fatigue* questionnaire. Practically, these findings emphasize the necessity of holistic clinical management in hemodialysis units, where *fatigue* evaluation should be systematically integrated alongside routine hemoglobin monitoring. Healthcare providers are encouraged to implement early nutritional interventions, targeted erythropoietin therapy, and energy conservation education, particularly during the critical early months of therapy. For future research, longitudinal cohort studies are recommended to track fatigue trajectories over time and examine additional biochemical parameters, such as inflammatory cytokines and comprehensive iron profiles.

CONCLUSION.

Based on data obtained from all respondents, the relationship between hemoglobin levels and *fatigue* severity among Chronic Kidney Disease (CKD) patients undergoing routine hemodialysis at Gatoel Hospital Mojokerto is statistically significant, strong, and

positive ($p = 0.000$, $r = 0.645$). This reflects that lower hemoglobin levels directly correspond to lower FACIT-*Fatigue* scores, indicating heightened *fatigue* severity. This is proven by the frequency distribution across the primary clinical categories evaluated in this study. On the aspect of hemoglobin level, the majority of respondents experienced severe anemia (<8.0 g/dL) with a percentage of 50.0%, which is classified as the predominant category. Second, for the aspect of moderate anemia (8.0–9.9 g/dL), the result is 38.2%, which is moderately high. The third aspect, mild anemia (9.9–10.0 g/dL), obtained a score of 11.8%, representing the lowest proportion. Furthermore, on the aspect of *fatigue* severity, respondents experiencing severe fatigue (≤ 30) reached a high percentage of 72.1%. And lastly, the aspect of mild fatigue (>30) presented with a percentage of 27.9% in the lower category.

Hemodialysis patients at Gatoel Hospital Mojokerto showed distinct clinical patterns across demographic characteristics alongside both typical and anomalous *fatigue* manifestations. Typical findings included patients with severe anemia predominantly reporting severe fatigue (94.1%), which is driven by tissue hypoxia, reduced cellular oxygen delivery, and cumulative systemic inflammation from routine dialytic sessions. Meanwhile, anomalous perceptions were identified in two severely anemic patients who reported only mild *fatigue*. These variations were influenced by protective non-hematological factors, including younger age with adaptive cardiovascular reserve, higher educational literacy that fosters effective self-care management, and unemployed status which reduces formal physical activity demands and allows self-regulated energy conservation at home.

REFERENCES

- Abdijalil, G. (2023). *Iatrogenic Errors in Hemodialysis Practices*.
- Abuadas, M. H., Albikawi, Z., & Khoury, O. (2025). The Functional Assessment of Chronic Illness Therapy-Fatigue Measure: Cross-Cultural Validation of an Arabic Version for Older Jordanians. *Iranian Journal of Nursing and Midwifery Research*, 30(1), 47–52. https://doi.org/10.4103/ijnmr.ijnmr_332_22
- Al-shair, K., Muellerova, H., Yorke, J., Rennard, S. I., Wouters, E. F. M., Hanania, N. A., Sharafkhaneh, A., & Vestbo, J. (2019). Examining fatigue in COPD: development, validity and reliability of a modified version of FACIT-F scale. *Health and Quality of Life Outcomes*, 10(30). <https://doi.org/10.1186/1477-7525-10-100>
- Alshammari, B., Alkubati, S. A., Alrasheeday, A., Pasay-An, E., Edison, J. S., Madkhali, N., Al-Sadi, A. K., Altamimi, M. S., Alshammari, S. O., Alshammari, A. A., & Alshammari, F. (2024). Factors influencing fatigue among patients undergoing hemodialysis: a multi-center cross-sectional study. *Libyan Journal of Medicine*, 19(1). <https://doi.org/10.1080/19932820.2023.2301142>
- Amruddin, Priyanda, R., Agustina, T. S., & Ariantini, N. S. (2022). *Metodologi Penelitian Kuantitatif* (M. P. Dr. Fatma Sukmawati (ed.); 1st ed.). Pradina Pustaka.
- Antony, E., James, M., Roy, A., & George, S. (2020). Assessment of Treatment Adherence and Its Predictors in Maintenance Hemodialysis Patients. *Asian Journal of Research in Nephrology*, 3(1), 102–109.

- Atiquzzaman, M., Er, L., Djurdjev, O., Bevilacqua, M., Elliott, M., Birks, P. C., Wong, M. M. Y., Yi, T. W., Singh, A., Tangri, N., & Levin, A. (2024). Implications of Implementing the 2021 CKD-EPI Equation Without Race on Managing Patients With Kidney Disease in British Columbia, Canada. *Kidney International Reports*, 9(4), 830–842. <https://doi.org/10.1016/j.ekir.2024.01.039>
- Depkes RI. (2008). *Pedoman pelayanan hemodialisis di sarana pelayanan kesehatan*.
- Dinas Kesehatan Provinsi Jawa Timur. (2024). *Profil Kesehatan Provinsi Jawa Timur*.
- Dinkes Kabupaten Mojokerto. (2024). Profil Kesehatan Kabupaten Mojokerto Tahun 2024. *Dinas Kesehatan Kabupaten Mojokerto*, 4, 1–209.
- FACIT Groups. (2024). *FACIT Fatigue Scale (Version 4)*. <https://doi.org/10.32388/00iir9>
- Francis, A., Harhay, M. N., Ong, A. C. M., Tummalapalli, S. L., Ortiz, A., & Fogo, A. B. (2024). Chronic kidney disease and the global public health agenda : an international consensus. *Nature Reviews Nephrology*, 20(July), 473–485. <https://doi.org/10.1038/s41581-024-00820-6>
- Hardani, Nur Hikmatul Auliya, G. C. B., Helmina Andriani, M. S., S.Si., M. P. R. A. F., S.Si., M. S. J. U., M.Farm., A. E. F. U., S.Si., M. S. D. J. S., & Ria Rahmatul Istiqomah, M. I. K. (2020). Metode Penelitian Kualitatif & Kuantitatif. In *Antimicrobial Agents and Chemotherapy* (Vol. 58, Issue 12).
- Hinkle, J. L., & Cheever, K. H. (2018). *Brunner & Suddarth's Textbook of Medical Surgical Nursing*.
- Ilsley, T., & Howden, E. J. (2023). Clinimetrics: Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-Fatigue). *Journal of Physiotherapy*, 69(4), 273–274. <https://doi.org/10.1016/j.jphys.2023.03.005>
- Indah, J., & Junaidi, J. (2017). Klasifikasi Kelompok Umur Manusia Berdasarkan Analisis Dimensi Fraktal Box Counting Dari Citra Wajah Dengan Deteksi Tepi Canny. *Jurnal Ilmiah Matematika*, 2(2), 42.
- Kartika, A., & Hayati, S. M. (2024). Fatigue Pada Pasien Hemodialisa. *Jurnal Pendidikan Tambusai*, 8(3), 40153–40157.
- KDIGO. (2024). Clinical Practice Guideline For The Evaluation And Management Of Chronic Kidney Disease. *Journal of The International Society of Nephrology*, 105(45), 1–199.
- KDIGO. (2026). Clinical Practice Guideline for the Management of Anemia in Chronic Kidney Disease (CKD). *Journal of The International Society of Nephrology*, 109(1), 1–99. <https://doi.org/10.1016/j.kint.2025.06.006>
- KDOQI. (2015). *Clinical Practice Guideline for Hemodialysis Adequacy*.
- KemenKes RI. (2023). *Profil Kesehatan Indonesia* (Ms. P. Farida Sibuea, SKM & M.

- Boga Hardhana, S.Si (eds.)). Kementerian Kesehatan RI.
- Kieffer, J. M., Ej, D., Boekhout, A., & Ma, E. (2021). A questionable factor structure of the multidimensional fatigue inventory in the general Dutch population. *Journal of Clinical Epidemiology*, 137, 266–276. <https://doi.org/10.1016/j.jclinepi.2021.05.005>
- Kim, D., Lee, J., Toyama, T., Liyanage, T., Woodward, M., & Matsushita, K. (2025). Prevalence and Treatment Patterns of Anaemia in Individuals With Chronic Kidney Disease Across Asia : A Systematic Review and Meta- - Analysis. *Nephrology*, 1–10. <https://doi.org/10.1111/nep.70002>
- Laksmiana, A. A., & Indriyawati, N. (2022). Fatigue Level Of Chronic Kidney Failure Patients After Undergoing Hemodialysis Therapy. *Jurnal Keperawatan Global*, 7(1), 29–42.
- Lerma, C., Lima-zapata, L. I., Amaya-aguilar, J. A., Leonardo-cruz, I., Lazo-s, M., Berm, L. A., P, H., Lerma, A., & Cadena-estrada, J. C. (2021). Gender-Specific Differences in Self-Care , Treatment-Related Symptoms , and Quality of Life in Hemodialysis Patients. *Int. J. Environ. Res. Public Health*, 18(13022), 1–11.
- Machali, I. (2021). *Metode Penelitian Kuantitatif* (A. Q. Habib (ed.); 3rd ed.).
- Maesaroh, Waluyo, A., & Jumaiyah, W. (2020). Faktor-faktor yang Berhubungan dengan Terjadinya Kelelahan pada Pasien Hemodialisis dan. *Jurnal Ilmiah Indonesia*, 5(4), 110–120.
- Mailani, F., Mansur, A. R., Rifdatunnisa, A., & Chan, C. M. (2025). *Factors Related to Fatigue among Chronic Kidney Disease Patients on Hemodialysis*. 15(April), 75–84.
- Mardiyah, A., Julianti, E., Giovana, L., & Raharjo, D. T. (2026). Association Between Hemoglobin Levels , Duration of Hemodialysis , and Mental Health Outcomes in CKD Patients : A Cross-Sectional Study Implications for Practice : Chronic Kidney Disease (CKD) is a According to the World Health Organiza. *Journal of Applied Nursing and Health*, 8(1), 837–850.
- National Kidney Foundation. (2022). *Frequently Asked Question About GFR Estimates*.
- Nugrahandari, A. S. I., Setyani, F. A., & Suparmi, L. (2024). Faktor-faktor yang mempengaruhi kelelahan pada pasien gagal ginjal kronis yang menjalani hemodialisis rutin di Rumah Sakit Pusat TNI AU dr. Suhardi Hardjolukito Yogyakarta. *Jurnal Penelitian Kesehatan*, 14(2), 66–77.
- Nurhalizah, E., Rustiawati, E., & Sulastri, T. (2025). Hubungan Antara Kadar Hemoglobin dengan Tingkat Kelelahan Pasca Hemodialisis pada pasien GGK di RSUD Provinsi Banten. *Universitas Sultan Ageng Tirtayasa, Serang, Indonesia*.
- Patimah, S., Kusumajaya, H., & M. Faizal, K. (2024). Faktor - Faktor Yang Berhubungan Dengan Fatigue Pada Pasien Gagal Ginjal Kronis Yang Menjalani Hemodialisis Di Rumah Sakit Umum Daerah Depati Bahrin Sungailiat Tahun 2024. *Jurnal Kesehatan Tambusai*, 5(4), 11003–11012. <https://doi.org/10.31004/jkt.v5i4.31920>

- Permenkes No.8. (2022). Peraturan Menteri Kesehatan Republik Indonesia. *Kementrian Kesehatan Republik Indonesia*, 317.
- PERNEFRI. (2019). *Prevensi Penyakit Ginjal Kronik Pada Rumah Sakit Tipe C*. Perhimpunan Nefrologi Indonesia.
- Qawasmeh, A., Salha, I., Mohammad, K., Farid, M., Tamimi, A., Hamdeh, N. A., Qassrawi, M., Najajra, D., Abu-haltam, A., & Alnees, M. (2025). Exploring the Relationship Between Fatigue Severity and Clinical Parameters in Hemodialysis Patients Utilizing FACIT-F Scale : A Cross-sectional Study in West Bank Hospitals. *International Journal of Nutrology*, 18(1), 1–6. <https://doi.org/10.1186/s12882-024-03647-2>
- Rafiullah, Jamal, Z., Iqbal, J., Rahat, A., & Sultan, A. (2023). Prevalence of Fatigue Among Patients with End Stage Renal Diseases with Special Emphasis on Quality of Life. *Journal of Asian Development Studies*, 12(3), 304–312.
- Rosdewi, Tola'ba, Y., Syahrul, M., & Tika, D. (2023). Pengaruh Hemodialisis Terhadap Nilai Hemoglobin Pasien End Stage Renal Disease di Ruang Hemodialisis Rumah Sakit Stella Maris Makassar. *Jurnal Ners Universitas Pahlawan*, 7(19), 68–73.
- Salsabila, H., Setyowati, L., Fikri, Z., & Sunardi, S. (2025). Effect of nutritional status on the incidence of anemia in hemodialysis patients. *Jurnal Keperawatan*, 16(1), 89–97. <https://doi.org/10.22219/jk.v16i1.41592>
- Santos, S., Lousa, I., Carvalho, M., Sameiro-faria, M., Santos-silva, A., & Belo, L. (2025). *Anemia in Elderly Patients : Contribution of Renal Aging and Chronic Kidney Disease*. 1–21.
- Santoso, D., Sawiji, Oktantri, H., & Septiwi, C. (2022). Faktor-faktor yang berhubungan dengan Fatigue pada pasien Gagal Ginjal Kronik yang menjalani Hemodialisa di RSUD dr. Soedirman Kebumen. *Jurnal Ilmiah Kesehatan Keperawatan*, 18(1), 60–70.
- Saraswati, N. L. G. I., & Lestari, N. K. Y. (2024). Tingkat Fatigue Pada Pasien Yang Menjalani Hemodialisis. *Journal Nursing Research Publication Media*, 3(2), 75–82. <https://doi.org/10.55887/nrpm.v3i2.128>
- Sharma, S., Alexander, K. E., Green, T., Wu, M. L., & Bonner, A. (2025). Energy conservation education intervention for people with end-stage kidney disease receiving haemodialysis (EVEREST): A two-arm parallel group study. *International Journal of Nursing Studies*, 166(March 2024). <https://doi.org/10.1016/j.ijnurstu.2025.105032>
- SKI. (2023). *Survei Kesehatan Indonesia Dalam Angka*. Kementerian Kesehatan RI.
- Su, F., Cao, L., Ren, X., Hu, J., Tavengana, G., Wu, H., Zhou, Y., Fu, Y., Jiang, M., & Wen, Y. (2023). Age and sex trend differences in hemoglobin levels in China: a cross-sectional study. *BMC Endocrine Disorders*, 23(1), 8. <https://doi.org/10.1186/s12902->

- Supriyadi, Susanto, H., & Ediati, A. (2021). Hubungan Antara Kadar Hemoglobin dengan Tingkat Kelelahan (fatigue) pada Pasien Penyakit Ginjal Kronik yang Telah Menjalani Hemodialisis. *Jurnal Keperawatan Volume*, 13(4), 889–894.
- Tsirigotis, S., Polikandrioti, M., Alikari, V., Dousis, E., Koutelekos, I., Toulia, G., Pavlatou, N., Panoutsopoulos, G. I., Leftheriotis, D., & Gerogianni, G. (2022). Factors Associated With Fatigue in Patients Undergoing Hemodialysis. *Cureus*, 14(3). <https://doi.org/10.7759/cureus.22994>
- Wang, B., Li, Z. L., Zhang, Y. L., Wen, Y., Gao, Y. M., & Liu, B. C. (2022). Hypoxia and chronic kidney disease. *EBioMedicine*, 77, 103942. <https://doi.org/10.1016/j.ebiom.2022.103942>
- WHO. (2025). *Reducing the burden of noncommunicable diseases through promotion of kidney health and strengthening prevention and control of kidney disease*. 4–9.
- Wong, M. M. Y., Tu, C., Li, Y., Perlman, R. L., Pecoits-filho, R., Lopes, A. A., Narita, I., Reichel, H., Port, F. K., Sukul, N., Stengel, B., Robinson, B. M., Massy, Z. A., Pisoni, R. L., & Investigators, C. (2020). *Anemia and iron deficiency among chronic kidney disease Stages 3 – 5ND patients in the Chronic Kidney Disease Outcomes and Practice Patterns Study: often unmeasured , variably treated*. 13(4), 613–624. <https://doi.org/10.1093/ckj/sfz091>
- Zhu, L., Li, X., Shi, R., & Wang, D. (2023). Dialysis vintage is associated with a high prevalence and severity of unpleasant symptoms in patients on hemodialysis. *Renal Failure*, 45(1). <https://doi.org/10.1080/0886022X.2023.2201361>