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# Prognostic Value of CONUT and PNI on Hemoglobin and Clinical Outcomes of Chronic Kidney Disease Patients: A Systematic Review

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***Abstract:*** *Malnutrition and chronic inflammation are prevalent complications in chronic kidney disease (CKD) that contribute to disease progression and high mortality rates. The Controlling Nutritional Status (CONUT) score and Prognostic Nutritional Index (PNI) are objective immunonutritional tools, yet their comparative prognostic value and specific relationship with hemoglobin decline in CKD patients require comprehensive evaluation. This study aims to systematically analyze the prognostic accuracy of CONUT and PNI scores in predicting clinical outcomes and their correlation with hemoglobin levels in CKD patients. A systematic literature review was conducted via PubMed and Google Scholar for primary cohort studies published between 2023 and 2026. Six studies meeting the inclusion criteria were analyzed qualitatively. The findings demonstrated that high CONUT and low PNI scores were significantly associated with lower hemoglobin levels and a higher risk of malnutrition in CKD patients. Both indices independently predicted adverse clinical outcomes, including renal progression and mortality. PNI consistently showed robust predictive capacity for mortality, while composite scores effectively stratified risk in dialysis populations. In conclusion, the CONUT score and PNI are reliable and cost-effective predictors of adverse clinical outcomes and hemoglobin decline in CKD patients. Routine immunonutritional screening using these indices is essential to optimize clinical management.*
***Keywords:*** *Hemoglobin; malnutrition; chronic kidney disease; PNI; CONUT score.*



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## INTRODUCTION

Chronic Kidney Disease (CKD) is a growing global health problem, characterized by progressive decline in kidney function that triggers various systemic complications (Bikbov, 2020; KDIGO CKD Work Group, 2024; Wang et al., 2024). One of the most prevalent but often undetected complications is chronic malnutrition and inflammation, which in the nephrology literature is often referred to as Protein-Energy Wasting (PEW) syndrome (Fouque, 2008; Li et al., 2025). In people with CKD—both in the early phase, progressive phase, or late stage of kidney disease (ESRD) that require hemodialysis or peritoneal dialysis—malnutrition conditions have been shown to significantly accelerate nephron damage and increase the risk

of cardiovascular mortality and general mortality (Kalantar-Zadeh, 2003; Yu et al., 2025). Furthermore, malnutrition in CKD patients has a very close pathophysiological relationship with hematological parameters, especially hemoglobin levels. Chronic systemic inflammation triggers the release of pro-inflammatory cytokines that not only suppress appetite and break down muscle proteins, but also directly inhibit erythropoiesis in the bone marrow and interfere with iron metabolism (Babitt, 2012; Loscalzo, 2022; Zhou et al., 2026). As a result, malnourished patients tend to experience a significant decrease in hemoglobin levels. (McClellan et al., 2004; Yu et al., 2025) This decrease in hemoglobin is not just a marker of common anemia, but has been identified as an independent risk factor that worsens nutritional status and accelerates fatal clinical outcomes (Yu et al., 2025; Zhou et al., 2026). Therefore, the identification of nutritional status that objectively integrates inflammatory status becomes essential to guide clinical interventions (Ikizler et al., 2020; Wang et al., 2024).

In clinical practice, particularly in referral hospitals with high patient volumes, conventional nutrition screening tools that rely on subjective interviews (such as Subjective Global Assessment) are often time-consuming and prone to assessor bias (Detsky, 1987; Li et al., 2025). Alternatively, laboratory-based objective immunonutrition indices such as Controlling Nutritional Status (CONUT) scores and Prognostic Nutritional Index (PNI) scores are increasingly recognized for their reliability. The CONUT score evaluates the level of malnutrition through the calculation of biochemical parameters that include serum albumin levels (protein reserves)(Owen et al., 1993), total cholesterol (calorie/lipid reserves), and peripheral blood lymphocyte counts (immune status) (Ignacio de Ulíbarri, 2005; Li et al., 2025). On the other hand, PNI integrates serum albumin and lymphocyte levels to provide a quick overview of the nutritional status and systemic inflammatory levels of patients in a single measure (Onodera, 1984; Zhang et al., 2023). Both of these scores are very cost-effective and the data can be extracted directly from the patient's medical records or routine blood tests.

Although CONUT and PNI have been shown to have good prognostic values, the literature comparing the accuracy of the two scores head-to-head in CKD populations is still not entirely consistent (Gohda et al., 2025). Some studies state that PNI is superior in predicting general mortality (Zhang et al., 2023), while other studies highlight the importance of integrating composite scores to predict risk in dialysis patients (Li et al., 2025). In addition, a comprehensive review of how fluctuations in CONUT and PNI scores are directly correlated with hemoglobin parameters in renal patients is still very limited. Understanding the comparative dynamics of these two scores is crucial for clinicians in performing accurate risk stratification. Therefore, this systematic literature review aims to analyze the prognostic accuracy of CONUT and PNI scores in predicting clinical outcomes, as well as to explore in depth the correlation between the two indices on hemoglobin levels in patients with Chronic Kidney Disease.

## RESEARCH METHODS

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This research is designed as a systematic literature review with a qualitative narrative synthesis approach. The writing and reporting of this review was prepared with reference to the standard guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). The literature search strategy is carried out comprehensively through the electronic academic databases PubMed and Google Scholar. The search is limited to articles published within the last three years, i.e. from 2023 to 2026, to ensure the novelty of the clinical data being evaluated. Search keywords are formulated using Boolean operators to expand and specify results, which include combinations: ("Controlling Nutritional Status" OR "CONUT") AND ("Prognostic Nutritional Index" OR "PNI") AND ("chronic kidney disease" OR "hemodialysis" OR "peritoneal dialysis").

The literature selection process is carried out based on strict inclusion and exclusion criteria. Inclusion criteria in this review include: (1) primary observational studies, such as prospective cohort, retrospective, and cross-sectional cohort studies; (2) the subject population is adult patients diagnosed with Chronic Kidney Disease (CKD) at various stages, including patients undergoing hemodialysis or peritoneal dialysis; (3) studies that explicitly evaluate and compare CONUT and/or PNI scores; and (4) studies that report measurable clinical outcomes, such as mortality rates, progressiveness of decline in kidney function, and their correlation with blood parameters such as hemoglobin.

Meanwhile, exclusion criteria are set to screen out irrelevant literature, which includes: literature review articles, meta-analyses, case reports, in vivo/in vitro animal studies, and studies whose full-text is not accessible or unpublished in English or Indonesian.

Data from the literature that met the inclusion criteria were then extracted into a standardization matrix. The data parameters collected included the author's name, year of publication, study design, number of samples, nutritional index used, hemoglobin level data, as well as significant findings related to hazard ratio or odds ratio from clinical outcomes. The data was then synthesized narratively to compare the accuracy and prognostic values of the immunonutrition index in CKD patients.

To ensure the validity of the findings, methodological quality and risk of bias of each included literature were assessed using the Newcastle-Ottawa Scale (NOS) instrument adapted specifically for observational studies. The assessment focused on three main domains: the representation of study group selection, comparability between groups, and the objectivity of determining clinical outcomes. All studies selected in this review achieved an NOS score of ≥ 7, indicating that all six literature had high methodological quality and low risk of bias.

## RESULTS AND DISCUSSION

Initial searches on PubMed and Google Scholar (2023–2026) identified 609 articles (17 PubMed, 592 Google Scholar). After 42 duplicate articles were removed, 567 articles were evaluated by title and abstract, of which 530 articles were excluded as irrelevant. Of the 37 potential manuscripts, 2 articles are not accessible in full-text. Furthermore, 35 full-text manuscripts were assessed for feasibility, and 29 of them were excluded because they did not directly compare CONUT and PNI, did not have hemoglobin data, or were not of a primary observational design. In the final stage, 6 articles were obtained that met all inclusion criteria to be synthesized qualitatively.

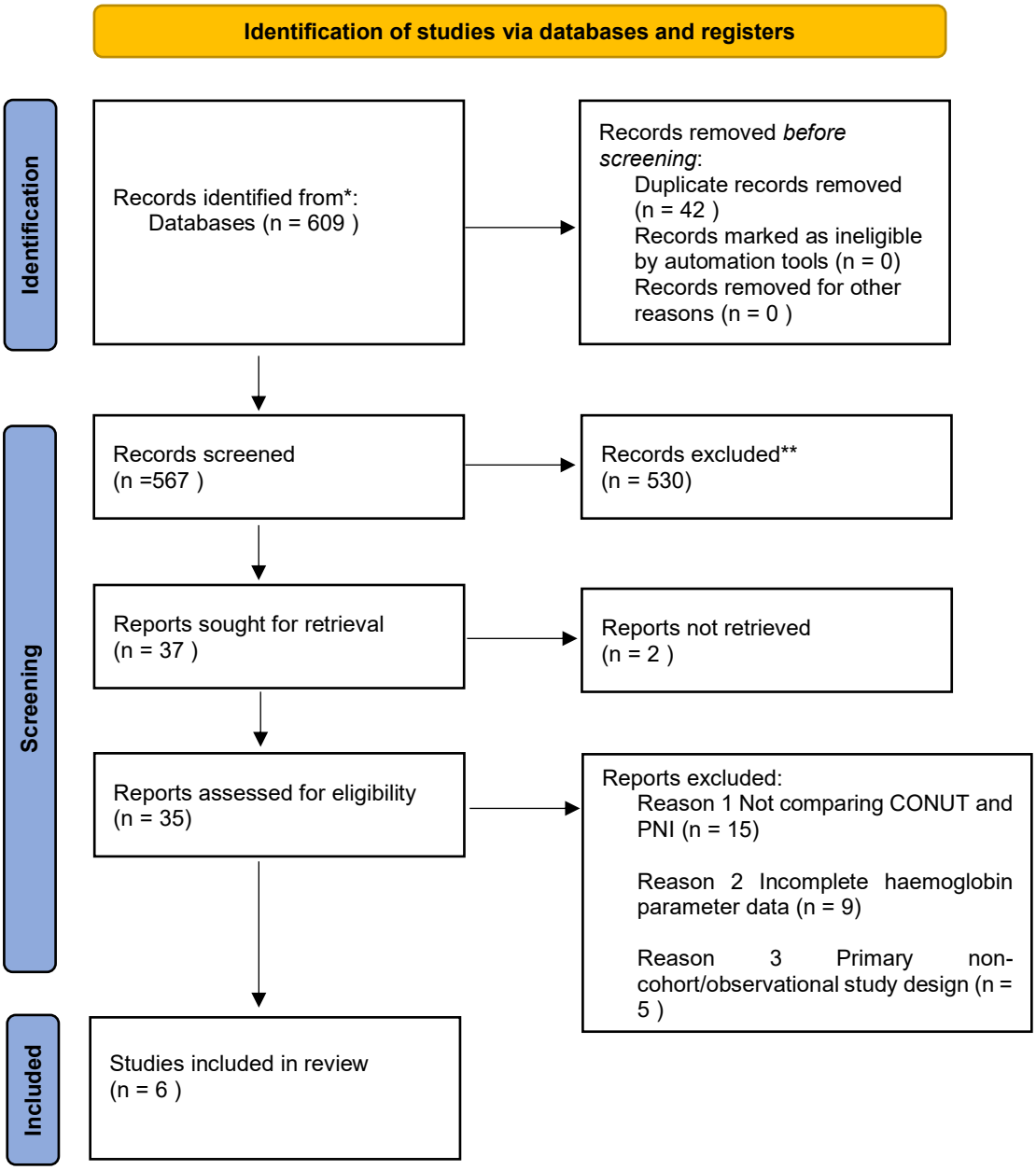

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**Table 1. Article Data Mapping Results**

| Penulis (Tahun) | Desain Studi & Populasi (N) | Indeks Nutrisi | Kaitan dengan Parameter Darah (Hemoglobin) | Luaran Utama (Outcomes) & Temuan Signifikan |
|---|---|---|---|---|
| **Yu et al., (2025)** | Cross-sectional; 1,277 CKD patients were hospitalized. | PNI, CONUT | Malnutrition patients have a much lower average Hb. Poor PNI: 99.00 g/L vs good PNI: 121.00 g/L. Bad NUT: 98.00 g/L vs good: 119.00 g/L. Decreased Hb is an independent risk factor for malnutrition. | 89.1% of patients at risk of malnutrition (PNI) & 87.7% (CONUT). Malnutrition is closely related to long length of hospitalization. |
| **Li et al., (2025)** | Retrospective cohort; 810 Dialisis Peritoneal patient (PD). | P-CONUT, CONUT, PNI | The median Hb in the High-CONUT (poor) group was 78.00 g/L compared to the good group (89.00 g/L). The Low-PNI group (poor) 73.00 g/L vs the good group (86.00 g/L) ($p<0.001$). | The combined P-CONUT score was the strongest independent predictor of mortality (AUC 0.790) beating single CONUT/PNI. |
| **Wang et al., (2024)** | Multicenter retrospective cohort; 863 Hemodialisis patient. | PNI, GNRI, CONUT | The poor PNI group had an average Hb of 78.5 g/L (vs 88.0 g/L). The poor CONUT group had an Hb of 79.0 g/L (vs 88.0 g/L) ($p<0.001$). | An increase in PNI & GNRI scores lowered the risk of cardiovascular mortality by 4% & 3%. GNRI is the most superior predictor. |
| **Gohda et al.(2025)** | Cohort; 640 individuals with Diabetic Kidney Disease (DKD). | PNI, GNRI, CONUT | The researchers made adjustments to various disruptive clinical variables, including Hemoglobin (HbA1c). | All three scores predicted a decrease in eGFR ≥30% and mortality independently, even beating the accuracy of the TNFR2 inflammatory biomarker. |
| **Zhang et al.(2023)** | Population study; 6,099 population of CKD patients in the U.S. (NHANES data). | PNI, SIS, NPS, CONUT | The measurement of this immunonutrient status index is compared head-to-head in a massive-scale kidney population. | PNI is proven to have the highest predictive power with a cutoff point of 51. High PNI independently lowers the risk of mortality. |
| **Zhou et al., (2026)** | Multicenter retrospective; 659 IgA Nephropathy patient (IgAN). | PNI, CONUT | Statistical analysis proves that PNI & CONUT remain independent risk factors even though they have been adjusted for Hemoglobin levels. | Low PNI (HR 2,514) and high CONUT (HR 2,152) predict very poor renal clinical outcomes. |

Based on the results of the literature data extraction, there are six observational studies that meet the inclusion criteria (Gohda et al., 2025; Li et al., 2025; Wang et al., 2024; Yu et al.,

2025; Zhang et al., 2023; Zhou et al., 2026). These six studies evaluated the use of immunonutrient indices, specifically Controlling Nutritional Status (CONUT) and Prognostic Nutritional Index (PNI) scores, in various groups of Chronic Kidney Disease (CKD) patients, ranging from inpatients to patients undergoing dialysis procedures.

Correlation of Immunonutrient Index with Hemoglobin Most of the literature shows a significant inverse relationship between immunonutrient status and hemoglobin levels. A cross-sectional study by Yu et al. (2025) on 1,277 inpatient CKD patients found that malnourished patients had lower average hemoglobin (Hb). The group with poor PNI and CONUT recorded Hb levels in the range of 98.00–99.00 g/L, much lower than the well-nourished group which reached 119.00–121.00 g/L (Yu et al., 2025). Similar findings were also seen in multicentric hemodialysis patients, where the group with poor PNI and CONUT had an average Hb of 78.5 g/L and 79.0 g/L, respectively (Wang et al., 2024). In peritoneal dialysis patients, the median Hb value in the high-risk group (High-CONUT) declined sharply to 78.00 g/L. This decrease in hemoglobin was statistically identified as an independent risk factor that was consistent with the severity of the patient's malnutrition (Li et al., 2025; Yu et al., 2025).

Prediction Accuracy of Clinical Outcomes In addition to blood parameters, this immunonutrient index has also been proven to be reliable in predicting patient clinical outcomes. Based on large-scale data analysis of the NHANES population in the United States, the PNI score has the highest predictive power with a cutoff point of 51; patients with PNI scores above these numbers independently have a lower risk of mortality (Zhang et al., 2023) In hemodialysis populations, an increase in nutrition scores is directly associated with a reduced risk of mortality due to cardiovascular problems (Wang et al., 2024). Furthermore, PNI and CONUT scores have been proven to remain consistent as independent predictors of the progression of kidney damage, even after statistical adjustments are made to various disruptive variables, including hemoglobin levels (Gohda et al., 2025; Zhou et al., 2026). For peritoneal dialysis patients, the use of combined scores such as P-CONUT was even considered to provide a stronger mortality prediction power (AUC 0.790) than conventional single indices (Li et al., 2025).

Malnutrition and inflammation are two medical conditions that often occur at the same time and aggravate each other in patients with Chronic Kidney Disease (CKD). (Carrero et al., 2013; Stenvinkel et al., 1999) The results of this literature review consistently show that laboratory-based objective screening tools, such as CONUT and PNI, are not only useful for assessing patients' nutritional status, but are also strongly associated with the decline of other important clinical parameters, such as hemoglobin levels and the risk of fatality.

The association between poor nutritional scores and low hemoglobin levels (Li et al., 2025; Wang et al., 2024; Yu et al., 2025) are closely related to the pathophysiology of Protein-Energy Wasting (PEW) syndrome. CONUT and PNI scores were assessed using biochemical indicators such as albumin and lymphocytes, which are highly sensitive to systemic inflammatory processes. In CKD patients who are malnourished, the high production of inflammatory cytokines will trigger protein breakdown while suppressing the process of red blood cell formation in the bone marrow (Raj, 2009; Zhou et al., 2026). In addition, this chronic inflammatory condition also interferes with the body's iron metabolism, thereby

inhibiting the synthesis of red blood cells. This mechanism explains why malnourished patients almost always show significantly lower hemoglobin levels than patients with preserved nutrition (Yu et al., 2025).

As a risk stratification instrument, PNI has been shown to be very strong in predicting general mortality rates (all-cause mortality) in large-scale populations (Zhang et al., 2023). On the other hand, since the CONUT calculation also takes into account total cholesterol levels, this score is considered more relevant to assess outputs related to metabolic energy reserves and the length of the patient's hospital stay (Yu et al., 2025). Nevertheless, recent clinical literature recommends that for patients with terminal conditions such as peritoneal dialysis patients, combining indicators into composite scores such as P-CONUT is more statistically ideal, as it is able to capture a more comprehensive picture of complications (Li et al., 2025).

Broadly speaking, the literature evaluated confirms that immunonutritional status screening is a crucial medical step. The fact that poor CONUT and PNI scores remain proven to be independent risk factors for impaired kidney function—even when the values have been adjusted for the patient's hemoglobin levels (Gohda et al., 2025; Zhou et al., 2026)—suggests that nutritional improvements can provide a broad protective effect that is not limited to treating anemia. Therefore, integrating CONUT and PNI scores into routine clinical examinations in hospitals is highly recommended, given that this method is easy to implement through medical records, objective, and cost-efficient.

While this systematic review provides comprehensive insights, there are some limitations of the study that need to be acknowledged. First, the number of primary literature evaluated was relatively limited (six studies), reflecting the lack of large-scale direct (head-to-head) comparative studies between CONUT and PNI scores in specific kidney populations. Second, the literature search strategy is focused on two main databases (PubMed and Google Scholar), so there is a possibility of relevant studies in other databases (such as Scopus or Embase) that are not identified. Third, there is a heterogeneity in the characteristics of the study populations involved—ranging from general inpatient CKD populations to acute peritoneal dialysis patients—that may influence the generalized interpretation of the hazard ratio (HR). Therefore, these findings should be interpreted taking into account the variation in each patient's clinical context.

## CONCLUSIONS AND SUGGESTIONS

There was a significant inverse correlation between immunonutrient index and

hemoglobin levels in patients with Chronic Kidney Disease (CKD). Controlling Nutritional Status Score (CONUT) and deteriorating Prognostic Nutritional Index (PNI) (indicating malnutrition) are consistently closely associated with low hemoglobin levels. This reflects the strong influence of systemic inflammation and Protein-Energy Wasting (PEW) syndrome on impaired red blood cell synthesis. CONUT and PNI scores were proven to have high prognostic accuracy and function as independent predictors of clinical outcomes of CKD patients, both in predicting the progression of decline in kidney function and cardiovascular mortality and general mortality. The use of composite scores (such as P-CONUT) in specific populations, such as peritoneal dialysis patients, provides superior predictive power over conventional single indices, allowing for more precise clinical risk stratification

Based on the conclusions obtained, it is recommended to health service institutions to integrate the calculation of CONUT and PNI scores into the standard operating procedures (SOPs) for routine examinations for CKD patients at various stages. Given that this index only requires objective and cost-effective basic laboratory data, its application can assist clinicians in detecting the risk of malnutrition and anemia complications early. For the next researcher, it is expected that there will be further research with a prospective cohort study design with a larger sample size in Indonesia, as well as an exploration of the effectiveness of specific nutrition interventions guided by monitoring CONUT and PNI scores on the improvement of hemoglobin parameters.

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