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Association Between Malnutrition–Inflammation Score and Health-Related Quality of Life Across KDQOL-36 Domains in Hemodialysis Patients

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ABSTRACT: Malnutrition–inflammation is common among patients receiving maintenance hemodialysis and may adversely affect health-related quality of life (HRQoL). This analytical cross-sectional study included 100 adult patients receiving maintenance hemodialysis at Dr. Wahidin Sudirohusodo General Hospital, Makassar, Indonesia. Malnutrition–inflammation status was assessed using the Malnutrition–Inflammation Score (MIS), while HRQoL was evaluated using the Bahasa Indonesia version of the Kidney Disease Quality of Life-36 (KDQOL-36), comprising the Physical Component Summary (PCS), Mental Component Summary (MCS), Symptoms/Problems of Kidney Disease (SPKD), Effects of Kidney Disease (EKD), and Burden of Kidney Disease (BKD). Associations were examined using Spearman correlation and multivariable linear regression adjusted for age, sex, education, and occupation. Higher MIS was significantly associated with lower scores across all KDQOL-36 domains: PCS ($\rho=-0.342$; $p=0.001$), MCS ($\rho=-0.315$; $p=0.001$), SPKD ($\rho=-0.288$; $p=0.004$), EKD ($\rho=-0.263$; $p=0.008$), and BKD ($\rho=-0.270$; $p=0.007$). In multivariable analyses, MIS remained significantly associated with each HRQoL domain after adjustment for sociodemographic factors, although the overall BKD model did not reach statistical significance. These findings indicate that greater malnutrition–inflammation burden is consistently associated with poorer physical, mental, symptom-related, disease-effect, and disease-burden dimensions of HRQoL in patients receiving hemodialysis.

1. INTRODUCTION

Patients receiving maintenance hemodialysis experience substantial symptom burden, functional limitations, psychological distress, and impaired health-related quality of life (HRQoL) [1,2]. HRQoL is multidimensional, and the KDQOL-36 distinguishes physical and mental health components from kidney-specific symptoms/problems, effects, and disease burden. Its Bahasa Indonesia version has demonstrated satisfactory validity and reliability in Indonesian dialysis populations [3].

Malnutrition–inflammation is another major concern in maintenance hemodialysis, but its relationship with HRQoL may not be uniform across dimensions. MIS was associated with physical and mental components in the study by Nagy et al. [4], whereas Ng et al. [5] identified associations particularly with physical functioning, PCS, and symptoms/problems. Among elderly hemodialysis patients, higher MIS was associated with poorer scores across several kidney-specific domains [6]. More recently, a multicenter study found adjusted associations of MIS with physical, mental, symptoms/problems, and disease-burden scores

[7]. Prospective evidence using SGA further supports an association between malnutrition and deterioration in HRQoL over time [8].

Indonesian studies have examined MIS in relation to overall or summary quality-of-life measures [9,10], but evidence regarding its associations with individual KDQOL-36 domains remains limited. Therefore, this study examined the associations between MIS and the five KDQOL-36 domains among patients receiving maintenance hemodialysis and evaluated whether these associations persisted after adjustment for sociodemographic factors.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This analytical cross-sectional study was conducted at the Hemodialysis Unit of Dr. Wahidin Sudirohusodo General Hospital, Makassar, Indonesia, between April and June 2026. The study evaluated the association between malnutrition–inflammation status and health-related quality of life (HRQoL) among adults receiving maintenance hemodialysis.

2.2 Participants and Sampling

Participants were recruited using purposive sampling from adult patients receiving maintenance hemodialysis at Dr. Wahidin Sudirohusodo General Hospital during the study period. Potential participants were screened according to predefined eligibility criteria. Patients were eligible if they were aged ≥ 18 years, had been receiving maintenance hemodialysis for at least 3 months, were conscious and able to communicate, and provided written informed consent. Patients with sepsis, active malignancy, or current hospitalization at the time of data collection were excluded.

The a priori sample size was calculated to detect a correlation coefficient of 0.30 with a two-sided α of 0.05 and 80% statistical power using the Fisher z -transformation approach for testing a correlation coefficient [11]. The calculation yielded a minimum sample size of 85 participants. To account for an anticipated 15% proportion of incomplete or unusable data, the required sample size was inflated by a factor of $1/(1-0.15)$, resulting in a target sample of 100 participants. All 100 enrolled participants had complete data and were included in the final analyses.

2.3 Malnutrition–Inflammation Assessment

Malnutrition–inflammation status was assessed using the Malnutrition–Inflammation Score (MIS), a multidimensional instrument developed for patients receiving maintenance dialysis [12]. The MIS comprises 10 components: change in body weight, dietary intake, gastrointestinal symptoms, functional capacity, comorbidity, subcutaneous fat, muscle wasting, body mass index, serum albumin, and total iron-binding capacity (TIBC). Each component is scored from 0 to 3, yielding a total score ranging from 0 to 30, with higher scores indicating greater malnutrition–inflammation severity.

Information on weight change, dietary intake, gastrointestinal symptoms, functional capacity, and comorbidities was obtained through structured interviews and clinical assessment. Subcutaneous fat loss and muscle wasting were assessed clinically in accordance with the MIS framework, with bioelectrical impedance analysis (BIA) used as supplementary body-composition information. Body mass index was calculated from measured body weight and height. Serum albumin and total iron-binding capacity (TIBC) were obtained from laboratory records. The component scores were combined to generate the total MIS score, with higher scores indicating greater malnutrition–inflammation severity.

For descriptive analyses, MIS scores were categorized as 0–5 for well-nourished status, 6–10 for mild malnutrition, and 11–20 for moderate malnutrition. MIS was retained as a continuous variable in all correlation and regression analyses to preserve the information contained in the full score.

2.4 Health-Related Quality of Life Assessment

Health-related quality of life (HRQoL) was assessed using the validated Bahasa Indonesia version of the 36-item Kidney Disease Quality of Life questionnaire (KDQOL-36). Participants completed the questionnaire during a scheduled hemodialysis session. The Indonesian version has demonstrated satisfactory validity and reliability in patients receiving hemodialysis [13], with subsequent multicenter psychometric evaluation further supporting its structural validity, convergent validity, internal consistency, and test–retest reliability in Indonesian dialysis populations [3].

The KDQOL-36 comprises a 12-item generic health component derived from the SF-12, from which the Physical Component Summary (PCS) and Mental Component Summary (MCS) scores are obtained, together with 24 kidney disease-specific items comprising the Symptoms/Problems of Kidney Disease (SPKD; 12 items), Effects of Kidney Disease (EKD; 8 items), and Burden of Kidney Disease (BKD; 4 items). Domain scores were transformed to a 0–100 scale, with higher scores indicating better HRQoL. All five domain scores were analyzed as continuous outcomes.

2.5 Covariates

Age, sex, educational attainment, and occupation were selected *a priori* as sociodemographic adjustment variables because they may be associated with both nutritional status and HRQoL and therefore represent plausible sources of confounding. These variables were prespecified before multivariable modelling rather than selected on the basis of univariable statistical significance. Age was categorized as 18–59 years or ≥ 60 years. Educational attainment was classified as primary school, junior high school, senior high school, or college/university. Occupation was classified as civil servant, non-civil servant, laborer, homemaker, or unemployed.

For multivariable analyses, age 18–59 years, male sex, college/university education, and unemployment were used as reference categories. Covariates were retained in all adjusted models irrespective of their individual statistical significance to maintain consistent confounding control across the five HRQoL domains.

2.6 Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Macintosh, version 30.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages. Continuous variables were summarized using appropriate measures of central tendency and dispersion according to their distribution. Associations between MIS and each KDQOL-36 domain were initially examined using Spearman's rank correlation coefficient. A two-sided *p* value < 0.05 was considered statistically significant.

Data completeness was assessed before statistical analysis. All 100 participants had complete data for the variables included in the analyses; therefore, no imputation was required, and all analyses were performed using the full study sample.

Multivariable linear regression analyses were subsequently performed to evaluate the independent association between MIS and each KDQOL-36 domain after adjustment for age, sex, educational attainment, and occupation. The enter method was used, with MIS and the prespecified sociodemographic covariates entered simultaneously into each model. Model performance was summarized using *R*, *R*², adjusted *R*², *F* statistics, and corresponding *p* values. Unstandardized and standardized regression coefficients were used to describe the magnitude and direction of the associations. Prior to interpretation of the regression models, assumptions of linearity, normality and homoscedasticity of residuals, independence of errors, and absence of problematic multicollinearity were assessed.

3. RESULTS AND DISCUSSION

3.1 Participant Characteristics and Study Measures

A total of 100 patients receiving hemodialysis were included in the analysis, with complete data available for all variables presented in Table 1. More than half of the participants were male (55.0%), and most were aged 18–59 years (78.0%). Senior high school and college/university were the most common educational levels, accounting for 38.0% and 36.0% of participants, respectively. The median Malnutrition–Inflammation Score (MIS) was 6.00 (Q1–Q3, 4.00–11.00); 40.0% of participants were classified as well nourished, whereas 30.0% had mild and 30.0% had moderate malnutrition. Among the KDQOL-36 domains, the highest median scores were observed for Symptoms/Problems of Kidney Disease and Effects of Kidney Disease, both at 68.75, whereas Burden of Kidney Disease had the lowest median score at 56.25.

Table 1. Participant characteristics and study measures (n=100)

Variable	Overall (n=100)
Sex, n (%)	
Male	55 (55.0)

Female	45 (45.0)
Age group, n (%)	
18–59 years	78 (78.0)
≥60 years	22 (22.0)
Education, n (%)	
Primary school	13 (13.0)
Junior high school	13 (13.0)
Senior high school	38 (38.0)
College/university	36 (36.0)
Occupation, n (%)	
Civil servant	8 (8.0)
Non-civil servant	25 (25.0)
Laborer	18 (18.0)
Homemaker	25 (25.0)
Unemployed	24 (24.0)
Malnutrition–Inflammation Score	6.00 (4.00–11.00)
MIS category, n (%)	
Well nourished	40 (40.0)
Mild malnutrition	30 (30.0)
Moderate malnutrition	30 (30.0)
KDQOL-36 domain scores	
Physical Component Summary (PCS)	59.38 (43.75–68.75)
Mental Component Summary (MCS)	62.50 (56.25–68.75)
Symptoms/Problems of Kidney Disease (SPKD)	68.75 (56.25–83.33)
Effects of Kidney Disease (EKD)	68.75 (50.78–78.13)
Burden of Kidney Disease (BKD)	56.25 (50.00–75.00)
Overall KDQOL-36 score	62.76 ± 11.42

Notes: Categorical variables are presented as n (%). Non-normally distributed continuous variables are presented as median (Q1–Q3), whereas normally distributed continuous variables are presented as mean ± SD. Higher MIS values indicate greater malnutrition–inflammation burden, whereas higher KDQOL-36 scores indicate better health-related quality of life. No missing data were present for the variables included in this table.

3.2 Unadjusted Associations Between MIS and KDQOL-36 Domains

Table 2 shows that higher MIS was significantly associated with lower scores across all five KDQOL-36 domains. Significant inverse correlations were observed for the Physical Component Summary (PCS; $\rho = -0.342$, $p = 0.001$), Mental Component Summary (MCS; $\rho = -0.315$, $p = 0.001$), Symptoms/Problems of Kidney Disease (SPKD; $\rho = -0.288$, $p = 0.004$), Effects of Kidney Disease (EKD; $\rho = -0.263$, $p = 0.008$), and Burden of Kidney Disease (BKD; $\rho = -0.270$, $p = 0.007$). The largest

correlation coefficient was observed for PCS, followed by MCS, SPKD, BKD, and EKD. Overall, higher malnutrition–inflammation severity was consistently associated with poorer physical, mental, and kidney disease-specific dimensions of health-related quality of life.

Table 2. Associations between Malnutrition–Inflammation Score and KDQOL-36 domains

KDQOL-36 domain	Spearman's ρ	p-value
Physical Component Summary (PCS)	−0.342	0.001
Mental Component Summary (MCS)	−0.315	0.001
Symptoms/Problems of Kidney Disease (SPKD)	−0.288	0.004
Effects of Kidney Disease (EKD)	−0.263	0.008
Burden of Kidney Disease (BKD)	−0.270	0.007

Note: Higher MIS scores indicate greater malnutrition–inflammation severity, whereas higher KDQOL-36 scores indicate better health-related quality of life. Negative coefficients therefore indicate poorer HRQoL with increasing MIS. $n=100$.

3.3 Adjusted Associations Between MIS and KDQOL-36 Domains

Higher MIS was independently associated with lower scores across all five KDQOL-36 domains after adjustment for age, sex, education, and occupation. Each one-point increase in MIS was associated with a 1.802-point decrease in PCS ($B=-1.802$; $\beta=-0.367$; $p<0.001$), a 1.516-point decrease in MCS ($B=-1.516$; $\beta=-0.384$; $p<0.001$), a 1.920-point decrease in SPKD ($B=-1.920$; $\beta=-0.350$; $p<0.001$), a 1.605-point decrease in EKD ($B=-1.605$; $\beta=-0.342$; $p=0.001$), and a 1.162-point decrease in BKD ($B=-1.162$; $\beta=-0.280$; $p=0.006$).

For the Physical Component Summary (PCS), the overall model was statistically significant ($F=7.891$, $p<0.001$) and explained 29.6% of the variance in PCS scores ($R^2=0.296$; adjusted $R^2=0.258$). In addition to MIS, sex ($p<0.001$) and occupation ($p=0.011$) were significantly associated with PCS.

For the Mental Component Summary (MCS), the model was also statistically significant ($F=5.839$, $p<0.001$), explaining 23.7% of the variance ($R^2=0.237$; adjusted $R^2=0.196$). Sex ($p=0.021$) and occupation ($p=0.035$) were additional significant predictors.

The Symptoms/Problems of Kidney Disease (SPKD) model was statistically significant ($F=3.458$, $p=0.007$), with an R^2 of 0.155 and an adjusted R^2 of 0.110. MIS was the only significant predictor in this model. Similarly, the Effects of Kidney Disease (EKD) model was significant ($F=3.963$, $p=0.003$), explaining 17.4% of the variance ($R^2=0.174$; adjusted $R^2=0.130$), with no other covariates reaching statistical significance.

For the Burden of Kidney Disease (BKD), MIS showed a significant adjusted association with the domain score; however, the overall regression model did not reach statistical significance ($F=2.007$, $p=0.085$), with an R^2 of 0.096 and an adjusted R^2 of 0.048. Overall, MIS showed significant adjusted associations across all five KDQOL-36 domains, although the explanatory performance of the models varied across domains.

Table 3. Multivariable linear regression models for KDQOL-36 domains

KDQOL-36 domain	MIS B	Standardized β	MIS p-value	R	R^2	Adjusted R^2	F	Model p-value
Physical Component Summary (PCS)	−1.802	−0.367	<0.001	0.544	0.296	0.258	7.891	<0.001
Mental Component Summary (MCS)	−1.516	−0.384	<0.001	0.487	0.237	0.196	5.839	<0.001
Symptoms/Problems of Kidney Disease (SPKD)	−1.920	−0.350	<0.001	0.394	0.155	0.110	3.458	0.007

Effects of Kidney Disease (EKD)	-1.605	-0.342	0.001	0.417	0.174	0.130	3.963	0.003
Burden of Kidney Disease (BKD)	-1.162	-0.280	0.006	0.311	0.096	0.048	2.007	0.085

Notes: B represents the adjusted change in the respective KDQOL-36 domain score per one-point increase in MIS. β represents the standardized regression coefficient. All models were adjusted for age, sex, education, and occupation using the enter method. Higher KDQOL-36 scores indicate better HRQoL; therefore, negative coefficients indicate lower HRQoL scores with increasing MIS. For BKD, MIS was significantly associated with the domain score, although the overall regression model was not statistically significant.

3.4 Discussion

This study demonstrated a consistent inverse relationship between malnutrition–inflammation and HRQoL among patients receiving maintenance hemodialysis. Higher MIS was significantly associated with lower scores across all five KDQOL-36 domains, including PCS, MCS, SPKD, EKD, and BKD. In adjusted analyses, MIS remained significantly associated with each domain after accounting for age, sex, education, and occupation, although the explanatory performance of the models varied and the overall BKD model did not reach statistical significance. Sixty percent of participants had MIS ≥ 5 , indicating mild-to-moderate malnutrition, a proportion comparable with the 62% classified as being at nutritional risk using the same threshold in Visiedo et al. [14] and the 51.7% with MIS ≥ 5 reported in a large Spanish multicenter cohort by Barril et al. [15].

The association with PCS is consistent with previous evidence. Nagy et al. (2021) found MIS to be the most significant nutritional predictor of the physical health component among maintenance hemodialysis patients, whereas none of the evaluated nutritional parameters independently predicted the mental component after multivariable adjustment [4]. Ng et al. (2022), in 379 patients, similarly reported that MIS ≥ 5 was associated with lower physical functioning, role limitation due to physical health, general health, and PCS scores, as well as lower symptoms/problems scores [5]. Visiedo et al. (2022) also showed that malnutrition was independently associated with lower kidney disease, physical, and mental summary scores [14]. These findings support the present results showing that poorer nutritional–inflammatory status is closely related to impaired physical and mental aspects of HRQoL.

This relationship is clinically plausible because MIS incorporates dietary intake, weight change, functional capacity, loss of fat and muscle stores, BMI, albumin, and TIBC, thereby capturing several features that may coexist with reduced physiological reserve and impaired functioning. Among older hemodialysis patients, Chen et al. (2022) found significant interrelationships among malnutrition, reduced muscle function, and depressive symptoms [16]. Separately, a systematic review and meta-analysis of 16 studies showed that hemodialysis patients with depression had substantially lower PCS and MCS scores than those without depression [17]. These observations do not establish a causal pathway from MIS to psychological impairment but illustrate the overlapping nutritional, functional, and psychological burden experienced by patients receiving long-term hemodialysis.

The significant associations observed for SPKD and EKD indicate that malnutrition–inflammation may also be reflected in kidney disease-specific experiences. Higher MIS was associated with poorer symptom-related HRQoL and greater perceived effects of kidney disease on daily life. This finding is consistent with Ng et al. (2022), who reported poorer symptoms/problems scores among patients with MIS ≥ 5 [5], and Bavi Behbahani et al. (2024), who found that higher MIS remained associated with poorer symptoms/problems scores after multivariable adjustment [7]. Kidney disease-related symptoms and treatment effects are multifactorial, but several components captured by MIS, including reduced dietary intake, gastrointestinal symptoms, functional limitation, and muscle wasting, may coexist with the symptom and treatment burden experienced during chronic dialysis. The relevance of symptom burden is further illustrated by Lopes et al. (2022), who showed that greater pruritus severity was associated with poorer HRQoL among patients receiving hemodialysis [18].

The association between MIS and BKD is also clinically relevant. BKD reflects the extent to which kidney disease interferes with patients' lives, including perceived dependency, treatment burden, and restrictions imposed by chronic dialysis. Bavi Behbahani et al. (2024) similarly reported an inverse adjusted association between MIS and the burden-of-kidney-disease score [7]. In the present study, MIS remained significantly associated with BKD after adjustment, although the overall BKD regression model did not reach statistical significance. This distinction suggests that MIS contributed to variation in perceived disease

burden, while the complete model may have had limited explanatory power for this domain. Other clinical, social, and psychological factors not included in the model may also contribute to how patients perceive the burden of kidney disease.

The findings also extend previous Indonesian evidence. Prabhaswari et al. (2020) reported a strong inverse association between MIS and overall KDQOL among hemodialysis patients in Bali [9], whereas Wardani et al. (2022) described relationships among MIS, IL-6, and overall quality of life [10]. The present study adds domain-level evidence by showing that the relationship between nutritional–inflammatory status and HRQoL extends across physical, mental, symptom-related, disease-effect, and disease-burden dimensions. Evaluating individual KDQOL-36 domains may therefore provide a more informative picture of patient well-being than relying solely on an overall quality-of-life score.

Clinically, MIS may serve as a useful marker of nutritional–inflammatory burden associated with multiple dimensions of patient-reported well-being. Nutritional assessment is an established component of CKD care [19], while symptom-specific and psychosocial assessment remains complementary. The clinical importance of HRQoL is further supported by Rincón Bello et al. (2024), who found that several KDQOL-36 dimensions were associated with subsequent mortality and hospitalization outcomes after adjustment for clinical characteristics [20]. These findings support incorporating nutritional assessment alongside multidimensional HRQoL evaluation in the routine assessment of patients undergoing maintenance hemodialysis.

Several limitations should frame interpretation. First, the cross-sectional design precludes establishing temporality or causality and does not allow determination of whether greater malnutrition–inflammation burden contributes to poorer HRQoL or whether poorer overall health and HRQoL are associated with worse nutritional–inflammatory status. Second, the relatively modest sample size of 100 participants from a single centre may limit the precision and generalizability of the findings. Third, although the multivariable models adjusted for age, sex, education, and occupation, residual confounding remains possible because potentially relevant clinical and treatment-related factors, including comorbidity burden, dialysis adequacy, dialysis vintage, anemia, depression, pruritus, medication use, and other dialysis-related treatment characteristics, were not comprehensively incorporated. MIS is a composite clinical score rather than a direct measure of systemic inflammation. In addition, the explanatory capacity of the regression models varied across HRQoL domains, particularly for BKD. Nevertheless, the use of continuous MIS scores, domain-specific HRQoL outcomes, and consistently specified multivariable models provides a comprehensive assessment of the relationship between malnutrition–inflammation and quality of life in this hemodialysis population.

4. CONCLUSION

Higher Malnutrition–Inflammation Score was consistently associated with poorer health-related quality of life across all five KDQOL-36 domains among patients receiving maintenance hemodialysis. The associations involved physical health, mental health, kidney disease-related symptoms, effects of kidney disease, and perceived disease burden, and MIS remained significantly associated with each domain after adjustment for sociodemographic factors, although the overall BKD regression model did not reach statistical significance. These findings support the clinical relevance of nutritional–inflammatory status across multiple dimensions of HRQoL. Given the cross-sectional design, causal relationships cannot be inferred. Future longitudinal multicenter studies incorporating broader clinical and psychosocial factors are warranted.

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AUTHOR CONTRIBUTIONS

Sri Windari Syafriani: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Visualization, Writing – Original Draft, and Project Administration.

Agussalim Bukhari: Conceptualization, Methodology, Supervision, Validation, Interpretation of Findings, and Writing – Review & Editing.

Haerani Rasyid: Conceptualization, Methodology, Supervision, Validation, Interpretation of Findings, and Writing – Review & Editing.

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All authors critically reviewed the manuscript, approved the final version, and agreed to be accountable for the accuracy and integrity of the work.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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ETHICS STATEMENT

The study protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine, Hasanuddin University (Approval No. 551/UN4.6.4.5.31/PP36/2026; Protocol ID UH26030448; approved April 22, 2026). The study was conducted in accordance with the principles of the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from all participants prior to enrollment.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to applicable ethical and institutional restrictions.

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