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Original Article

Prevalence and factors associated with malnutrition among patients with pre-dialysis chronic kidney disease stages 3–5

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Abstract

Malnutrition is a common and clinically significant complication in patients with chronic kidney disease (CKD), contributing to increased morbidity and mortality. However, evidence regarding its prevalence and associated factors in pre-dialysis CKD remains limited. The aim of this study was to determine the prevalence of malnutrition, compare its distribution across CKD stages, and identify factors associated with malnutrition in patients with pre-dialysis CKD stages 3–5. This cross-sectional study included patients with CKD stages 3–5 attending the nephrology clinic at Rajavithi Hospital, Thailand, between January and December 2025. Nutritional status was assessed using the Nutrition Alert Form (NAF). Demographic, clinical, dietary, and laboratory data were collected. Factors associated with malnutrition were analyzed using logistic regression. A total of 313 patients were included. The prevalence of malnutrition was 39.30%, including 34.50% moderate and 4.79% severe malnutrition. Independent factors associated with malnutrition included underweight (adjusted OR (aOR): 5.10; 95%CI: 1.26–20.68), severe obesity (aOR: 7.33; 95%CI: 2.53–21.22), history of stroke (aOR: 85.23; 95%CI: 19.23–377.70), weight loss within 4 weeks (aOR: 7.55; 95%CI: 2.92–19.51), increased weight within 4 weeks (aOR: 3.10; 95%CI: 1.19–8.07), reduced dietary intake (aOR: 46.42; 95%CI: 10.39–207.38), impaired food access (aOR: 10.63; 95%CI: 2.88–39.23), CKD stage 5 (aOR: 2.22; 95%CI: 1.14–4.31), higher serum creatinine (aOR: 1.86; 95%CI: 1.19–2.90), and lower lymphocyte percentage (aOR: 0.93; 95%CI: 0.89–0.97). Malnutrition was highly prevalent among patients with pre-dialysis CKD stages 3–5, and the findings suggest a possible U-shaped association between body habitus and malnutrition, with both underweight and severe obesity independently associated with increased nutritional risk. These findings support the importance of routine nutritional screening across all CKD stages regardless of BMI status and may help identify patients at increased nutritional risk.

Keywords: Chronic kidney disease, malnutrition, prevalence, nutrition alert form, pre-dialysis

Introduction

Chronic kidney disease (CKD) is a major global health problem with increasing prevalence and significant healthcare burden [1]. As kidney function declines, CKD patients are at high risk of developing metabolic complications, including protein–energy wasting (PEW), which is strongly associated with adverse clinical outcomes such as increased hospitalization and mortality [2-4]. Although PEW and malnutrition overlap substantially, they are not synonymous. PEW is a

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specific metabolic and nutritional syndrome characterized by the loss of body protein and energy stores and is defined according to criteria proposed by the International Society of Renal Nutrition and Metabolism (ISRNM) [5], whereas malnutrition may be identified using nutritional screening or assessment tools [2].

Malnutrition in CKD is multifactorial, involving reduced dietary intake, chronic inflammation, metabolic acidosis, hormonal imbalance, and comorbid conditions [6]. Importantly, malnutrition can develop even before the initiation of kidney replacement therapy (KRT), yet it is often under-recognized in clinical practice [6-8]. Previous studies have reported varying prevalence rates of malnutrition in pre-dialysis CKD populations, ranging from approximately 30% to 50%, depending on the assessment methods used [9-11]. However, data from Southeast Asia remain limited, and differences in healthcare systems, dietary patterns, and socioeconomic factors may influence nutritional status. Therefore, the aim of this study was to determine the prevalence of malnutrition in patients with pre-dialysis CKD stages 3–5, to compare its distribution across CKD stages, and to identify factors associated with malnutrition in a tertiary care setting in Thailand.

Methods

Study design and participants

A cross-sectional study was conducted at the Chronic Kidney Disease Clinic, Rajavithi Hospital, Bangkok, Thailand, between January and December 2025. Adult patients aged 18 years or older with pre-dialysis CKD stages 3–5 (estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m²) who attended the clinic during the study period were screened for eligibility. Eligible participants were required to be able to complete the Nutrition Alert Form (NAF) independently or with assistance from a caregiver. Participants with complete information required for NAF assessment from medical records were also eligible. In addition, laboratory data including complete blood count (CBC), blood urea nitrogen (BUN), serum creatinine, and serum albumin measured within 3 months before enrollment were required. Exclusion criteria included acute kidney injury, unstable kidney function defined as a change in eGFR greater than 25% within the preceding three months, pregnancy or breastfeeding, and incomplete medical records. Written informed consent was obtained from all participants before enrollment.

Sample size calculation

The sample size was calculated using a single population proportion formula to estimate the prevalence of malnutrition among patients with pre-dialysis CKD. Based on a previous study reporting a malnutrition prevalence of 46.7% in pre-dialysis CKD patients [9], the expected proportion (p) was set at 0.467. A 95% confidence level was applied, corresponding to a standard normal deviate (Z) of 1.96, with an acceptable margin of error (d) of 0.07. The required sample size was calculated using the following formula: $n=Z^2\times p\times(1-p)/d^2$, where n represents the minimum required sample size, Z is the standard normal deviate for a 95% confidence level, p is the expected prevalence of malnutrition, and d is the acceptable margin of error. Substitution of these values yielded a minimum required sample size of 196 participants. To compensate for an anticipated 20% dropout or incomplete data rate, the target sample size was increased to 240 participants. Ultimately, 313 eligible patients were included in the final analysis, exceeding the minimum required sample size and providing adequate statistical power for the study objectives.

Data collection and study variables

Demographic characteristics, anthropometric measurements, nutritional assessment, comorbidities, functional status, dietary intake, food accessibility, and laboratory parameters were collected from patient interviews and electronic medical records. Demographic characteristics included age and sex. Anthropometric measurements included body mass index (BMI), calculated as weight in kilograms divided by height in meters squared (kg/m²), and classified according to the Asia-Pacific criteria as underweight (<18.5 kg/m²), normal weight (18.5–22.9 kg/m²), overweight (23.0–24.9 kg/m²), moderately obese (25.0–29.9 kg/m²), and severely obese (≥30.0 kg/m²) [12]. Comorbidities, including hypertension, diabetes mellitus,

dyslipidemia, congestive heart failure, chronic obstructive pulmonary disease, liver disease, malignancy, and stroke/cerebrovascular disease, were identified from physician-documented diagnoses in electronic medical records. Functional status was classified according to the patient's ability to perform daily activities as normal activity, limited activity, or bedridden/need assistance. Functional status was used to support the classification of food accessibility. Participants who were bedridden/needed assistance or had limited activity were categorized as having impaired food access, whereas those with normal activity were categorized as having normal food access. Nutritional assessment was performed using NAF tool. Information regarding recent weight change, dietary intake during the previous four weeks, and food accessibility was obtained from the NAF interview. Laboratory parameters included blood urea nitrogen, serum creatinine, estimated glomerular filtration rate (eGFR), serum albumin, hemoglobin, white blood cell count, and lymphocyte percentage obtained from laboratory records within three months before enrollment. CKD stage was classified according to Kidney Disease Improving Global Outcomes (KDIGO) 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease based on eGFR calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation [13].

Nutritional assessment

Nutritional status was assessed using NAF questionnaire, a validated nutritional screening tool developed and widely used in Thailand [14]. The NAF has been validated against established nutritional assessment methods, including the Subjective Global Assessment (SGA), and has demonstrated good diagnostic performance in patients with CKD [15]. The instrument evaluates recent weight change, dietary intake, gastrointestinal symptoms, functional capacity, disease severity, and anthropometric parameters. Total NAF scores were categorized as normal or mild nutritional risk (0–5 points), moderate malnutrition (6–10 points), and severe malnutrition (≥11 points) [14,15].

Study outcomes

The primary outcome was the prevalence of malnutrition among patients with pre-dialysis CKD stages 3–5. Secondary outcomes included the comparison of malnutrition prevalence across CKD stages and the identification of factors associated with malnutrition.

Statistical analysis

Comparisons between groups were performed using the independent t-test or Mann–Whitney U test for continuous variables and the chi-squared test or Fisher's exact test for categorical variables, as appropriate. Since CKD stages represent ordered categories, a Cochran–Armitage trend test was performed to assess the linear trend in the prevalence of malnutrition across CKD stages. Factors associated with malnutrition were initially evaluated using univariate logistic regression analysis, and variables with $p<0.10$ were considered for inclusion in the multivariate logistic regression model. Multicollinearity among predictors was assessed using variance inflation factors (VIFs). All VIF values were below 5, indicating no evidence of problematic multicollinearity. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) were calculated in multivariate model. Statistical significance was defined as a two-sided $p<0.05$. All analyses were performed using SPSS version 29 (IBM Corp., Armonk, NY, USA).

Results

Study population

Of 618 patients assessed for eligibility, 313 were included in the final analysis after excluding 305 patients because of missing data (n=168), failure to meet the inclusion criteria (n=93), or refusal to participate (n=44). The majority of excluded patients lacked complete nutritional or laboratory information required for NAF assessment and multivariable analysis. Nutritional assessment using NAF identified 123 patients with malnutrition and 190 patients without malnutrition. The participant selection process is illustrated in **Figure 1**.

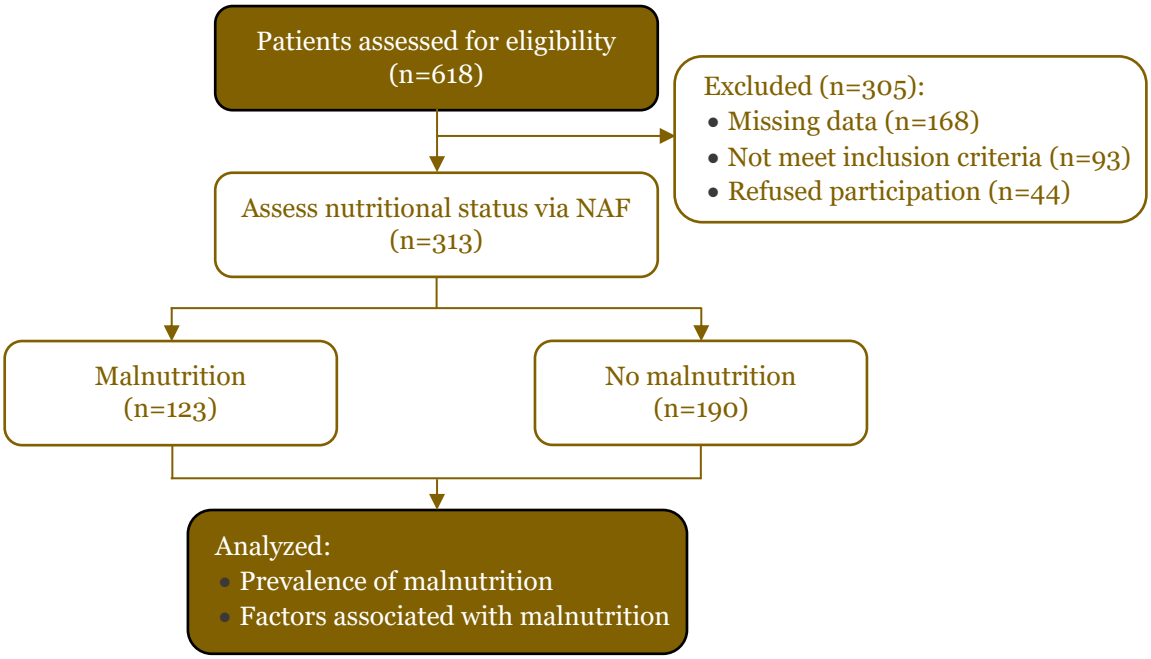

Figure 1. Flow diagram of participant selection and study inclusion. Patients with pre-dialysis chronic kidney disease stages 3–5 were assessed for eligibility. Eligible participants with complete nutritional and laboratory data were included in the final analysis and classified according to nutritional status using the Nutrition Alert Form (NAF).

Participant characteristics

A total of 313 patients with pre-dialysis CKD stages 3–5 were included in this study and their characteristics are presented in **Table 1**. The mean age was 66.5±13.9 years, and 160 patients (51.1%) were female. The mean BMI was 25.2±5.2 kg/m². The most common comorbidities were hypertension (85.0%), diabetes mellitus (59.4%), and dyslipidemia (59.1%). A history of stroke or cerebrovascular disease was present in 34 patients (10.9%). Most participants were classified as having normal activity, indicating that they were able to perform usual daily activities without significant functional limitation (85.9%). Consistent with this finding, food accessibility was normal in 269 patients (85.9%), whereas 44 patients (14.1%) were classified as having impaired food access. Regarding CKD stage, 144 patients (46.0%) had CKD stage 3, 112 (35.8%) had CKD stage 4, and 57 (18.2%) had CKD stage 5. The mean eGFR was 28.4±14.0 mL/min/1.73 m², mean serum creatinine was 2.69±1.82 mg/dL, and mean serum albumin was 4.65±0.43 g/dL (**Table 1**).

Table 1. Baseline demographic, clinical, and laboratory characteristics of study participants (n=313)

Characteristics	Frequency (percentage)
Age, mean±SD	66.47±13.92
Gender: female	160 (51.1)
Body mass index (kg/m²)	25.21±5.17
Comorbidities	
Hypertension	266 (85.0)
Diabetes mellitus	186 (59.4)
Dyslipidemia	185 (59.1)
Chronic heart failure	13 (4.1)
Chronic obstructive pulmonary disease	4 (1.2)
Liver disease	17 (5.4)
Solid cancer	16 (5.1)
Hematologic malignancy	4 (1.28)
Stroke/cerebrovascular disease	34 (10.9)
Functional status	
Bedridden/need assistance	24 (7.7)
Limited activity	20 (6.4)
Normal	269 (85.9)

Characteristics	Frequency (percentage)
Food accessibility	
Normal	269 (85.9)
Impaired food access	44 (14.1)
Chronic kidney disease (CKD) stage	
CKD stage 3	144 (46.0)
CKD stage 4	112 (35.8)
CKD stage 5	57 (18.2)
Laboratory, mean±SD	
Blood urea nitrogen (mg/dL)	36.26±20.86
Creatinine (mg/dL)	2.69±1.82
Estimated glomerular filtration rate (eGFR, mL/min/1.73m^2)	28.42±14.00
Albumin (g/dL)	4.65±0.43
White blood cell (cells/mm^3)	7295.01±2479.80
Hemoglobin (g/dL)	11.35±2.77
Lymphocyte (%)	27.73±9.68

Prevalence of malnutrition

The overall prevalence of malnutrition was 39.3% (123/313). Of these, 108 patients (34.5%) had moderate malnutrition, and 15 patients (4.8%) had severe malnutrition according to the NAF criteria (**Table 2**).

Table 2. Prevalence and severity of malnutrition among patients with pre-dialysis chronic kidney disease (n=313)

Status of malnutrition based on Nutrition Alert Form (NAF)	Frequency (percentage)
No malnutrition	190 (60.7)
Malnutrition	123 (39.3)
Moderate malnutrition	108 (34.5)
Severe malnutrition	15 (4.8)

Malnutrition across CKD stages

The prevalence of malnutrition increased progressively across CKD stages, from 34.0% in CKD stage 3 to 40.2% in CKD stage 4 and 50.9% in CKD stage 5 (**Table 3**). Although the prevalences among the stages were not statistically significant (overall chi-squared comparison had p=0.086), a Cochran–Armitage trend test demonstrated a significant increasing trend in malnutrition prevalence across CKD stages (p=0.029) (**Table 3**).

Table 3. Prevalence of malnutrition across stages of chronic kidney disease

CKD stage	Malnutrition	No malnutrition	p-value
	n (%)	n (%)	
Stage 3 (n=144)	49 (34.0)	95 (66.0)	
Stage 4 (n=112)	45 (40.2)	67 (59.8)	
Stage 5 (n=57)	29 (50.9)	28 (49.1)	
Overall			0.086*
Trend test			0.029**

*Overall comparison across CKD stages; assessed using chi-squared test
**Assessed using Cochran–Armitage trend test

Factors associated with malnutrition

In the univariate logistic regression analysis, underweight, stroke, recent weight loss, reduced dietary intake, increased dietary intake, impaired food access, higher serum creatinine levels, and lower lymphocyte percentage were significantly associated with malnutrition (**Table 4**). Severe obesity and CKD stage 5 showed borderline associations and were subsequently included in the multivariate model. In the multivariate logistic regression analysis, underweight, severe obesity, stroke, recent weight loss, increased weight within the previous four weeks, reduced dietary intake, impaired food accessibility, CKD stage 5, higher serum creatinine, and lower lymphocyte percentage remained independently associated with malnutrition (**Table 5**). Stroke (aOR 85.23), reduced dietary intake (aOR 46.42), and impaired food accessibility (aOR 10.63) demonstrated the strongest associations with malnutrition (**Table 5**).

Table 4. Univariate logistic regression analysis of factors associated with malnutrition among pre-dialysis patients with CKD stages 3–5

Variables	Malnutrition n (%)	No malnutrition n (%)	Odds ratio (95% confidence interval)	*p*–value
Age (years), mean±SD	66.86±15.67	66.22±12.70	1.00 (0.99–1.02)	0.688
Female sex	65 (40.6)	95 (59.4)	1.13 (0.72–1.78)	0.591
Body mass index (BMI) categories				
Underweight (<18.5)	15 (71.4)	6 (28.6)	3.73 (1.21–11.49)	0.022*
Normal weight (18.5–22.9)	36 (39.1)	56 (60.9)	1.00	Reference
Overweight (23.0–24.9)	16 (26.2)	45 (73.8)	0.55 (0.27–1.12)	0.101
Moderately obese (25.0–29.9)	28 (32.2)	59 (67.8)	0.74 (0.40–1.36)	0.333
Severely obese (≥30.0)	28 (53.9)	24 (46.1)	1.81 (0.91–3.61)	0.089
Underlying disease				
Hypertension	110 (41.3)	156 (58.7)	1.84 (0.78–3.66)	0.180
Diabetes mellitus	79 (42.5)	107 (57.5)	1.39 (0.87–2.22)	0.164
Dyslipidemia	81 (43.8)	104 (56.2)	1.59 (0.98–2.55)	0.151
Solid cancer	8 (50.0)	8 (50.0)	1.58 (0.58–4.33)	0.372
Congestive heart failure	7 (53.9)	6 (46.1)	1.85 (0.61–5.64)	0.279
Chronic obstructive pulmonary disease	1 (25.0)	3 (75.0)	0.51 (0.05–4.97)	0.563
Liver disease	7 (41.2)	10 (58.8)	1.09 (0.40–2.93)	0.870
Stroke/cerebrovascular disease	31 (91.2)	3 (8.8)	21.00 (6.26–70.51)	<0.001**
Hematologic malignancy	3 (75.0)	1 (25.0)	4.73 (0.49–45.95)	0.181
Weight change within past 4 weeks				
Stable	55 (29.9)	129 (70.1)	1.00	Reference
Decreased	41 (68.3)	19 (31.7)	5.06 (2.70–9.49)	<0.001**
Increased	21 (37.5)	35 (62.5)	1.41 (0.75–2.63)	0.285
Food intake within past 4 weeks				
Normal	74 (29.0)	181 (71.0)	1.00	Reference
Reduced	39 (92.9)	3 (7.1)	31.80 (9.53–106.10)	<0.001**
Increased	10 (62.5)	6 (37.5)	4.08 (1.43–11.62)	0.009**
Food accessibility				
Normal	85 (31.6)	184 (68.4)	1.00	Reference
Impaired food access	38 (86.4)	6 (13.6)	13.71 (5.58–33.67)	<0.001**
Chronic kidney disease stage (based on eGFR category)				
Stage 3	49 (34.0)	95 (66.0)	1.00	Reference
Stage 4	45 (40.2)	67 (59.8)	1.19 (0.60–2.38)	0.614
Stage 5	29 (50.9)	28 (49.1)	1.84 (0.85–4.00)	0.123
Blood urea nitrogen (mg/dL), mean±SD	37.82±15.38	34.03±17.01	1.01 (0.98–1.03)	0.691
Serum creatinine (mg/dL), median (IQR)	2.23 (1.05:15.83)	1.98 (0.97:7.98)	1.24 (1.08–1.43)	0.003**
eGFR (mL/min/1.73m²), mean±SD	26.9±14.28	30.05±13.60	0.97 (0.92–1.03)	0.351
Albumin (g/dL), mean±SD	5.3±0.71	4.23±0.43	1.07 (0.99–1.16)	0.107
White blood cell (cells/µL), mean±SD	7374±2496.24	7243±2474.36	1.00 (1.00–1.00)	0.651
Hemoglobin (g/dL)	11.26±2.63	11.77±2.89	0.95 (0.87–1.03)	0.204
Lymphocyte (%), mean±SD	25.07±9.01	29.46±9.73	0.95 (0.93–0.98)	<0.001**

eGFR: estimated glomerular filtration rate
Reference indicates the comparator category in logistic regression
*Statistically significant at $p<0.05$
**Statistically significant at $p<0.01$

Table 5. Multivariate logistic regression analysis of factors associated with malnutrition among pre-dialysis patients with CKD stages 3–5

Variables	Malnutrition n (%)	No malnutrition n (%)	Adjusted OR (95%CI)	*p*–value
Body mass index (BMI) categories				
Underweight (<18.5)	15 (71.4)	6 (28.6)	5.10 (1.26–20.68)	0.023*
Normal weight (18.5–22.9)	36 (39.1)	56 (60.9)	1	Reference
Overweight (23.0–24.9)	16 (26.2)	45 (73.8)	1.09 (0.33–3.59)	0.882
Moderately obese (25.0–29.9)	28 (32.2)	59 (67.8)	1.25 (0.45–3.48)	0.670
Severely obese (≥30.0)	28 (53.9)	24 (46.1)	7.33 (2.53–21.22)	<0.001**
Cerebrovascular accident (stroke)	31 (91.2)	3 (8.8)	85.23 (19.23–377.70)	<0.001**
Weight change within past 4 weeks				
Stable	55 (29.9)	129 (70.1)	1	Reference
Decreased	41 (68.3)	19 (31.7)	7.55 (2.92–19.51)	<0.001**
Increased	21 (37.5)	35 (62.5)	3.10 (1.19–8.07)	0.021*
Food intake within past 4 weeks				
Normal	74 (29.0)	181 (71.0)	1	Reference
Reduced	39 (92.9)	3 (7.1)	46.42 (10.39–207.38)	<0.001**
Increased	10 (62.5)	6 (37.5)	2.79 (0.61–12.80)	0.188
Food accessibility				
Normal	85 (31.6)	184 (68.4)	1	Reference
Impaired food access	38 (86.4)	6 (13.6)	10.63 (2.88–39.23)	<0.001**
CKD stage (eGFR category)				
Stage 3	49 (34.0)	95 (66.0)	1	Reference
Stage 4	45 (40.2)	67 (59.8)	1.16 (0.68–2.00)	0.589
Stage 5	29 (50.9)	28 (49.1)	2.22 (1.14–4.31)	0.018*
Serum creatinine (mg/dL), median (IQR)	2.23 (1.05:15.83)	1.98 (0.97:7.98)	1.86 (1.19–2.90)	0.007**
Lymphocyte (%), mean±SD	25.07±9.01	29.46±9.73	0.93 (0.89–0.97)	0.001**

CI: confidence interval; CKD: chronic kidney disease; eGFR: estimated glomerular filtration rate; OR: odds ratio.
Reference indicates the comparator category in logistic regression.
*Statistically significant at $p<0.05$
**Statistically significant at $p<0.01$

Discussion

This cross-sectional study showed that malnutrition was common among patients with pre-dialysis CKD stages 3–5, affecting 39.3% of participants, with most cases classified as moderate malnutrition and 4.8% as severe malnutrition. This finding indicates that nutritional impairment is already present before the initiation of kidney replacement therapy and is consistent with previous studies reporting malnutrition rates of approximately 30%–50% among patients with non-dialysis CKD [9-11]. Malnutrition in CKD is closely related to protein–energy wasting (PEW), although the two conditions are not synonymous. PEW is a metabolic and nutritional syndrome characterized by loss of body protein and energy stores [3-6], whereas this study assessed nutritional status using the Nutrition Alert Form (NAF). Therefore, the findings should be interpreted as factors associated with NAF-defined malnutrition rather than a formal diagnosis of PEW [5,6].

Previous studies have also reported that malnutrition is frequent among patients with pre-dialysis CKD [9,10]. In the present study, malnutrition increased progressively with CKD stage, from 34.0% in stage 3 to 40.2% in stage 4 and 50.9% in stage 5. Although the overall comparison across CKD stages was not statistically significant, the Cochran–Armitage trend test showed a significant increasing trend, and CKD stage 5 remained independently associated with malnutrition in the multivariable model. This supports an ordered association between advancing kidney dysfunction and nutritional risk, although it should not be interpreted as a significant difference across all CKD stage groups simultaneously [11,16,17].

Several variables associated with malnutrition in the multivariable analysis, including recent weight change, dietary intake, and food accessibility, are components of the NAF. Therefore, these associations should be interpreted as characteristics linked to NAF-defined nutritional classification rather than independent etiological determinants. Incorporation bias cannot be excluded and should be considered when interpreting these findings. History of stroke showed

the strongest association with malnutrition. This relationship is biologically plausible because stroke may impair mobility, functional independence, swallowing ability, food preparation, and oral intake [18-20]. However, the very large odds ratio and wide confidence interval suggest limited precision, likely due to the small number of patients with stroke, particularly among those without malnutrition. Therefore, although the direction of the association is clinically plausible, its magnitude should be interpreted cautiously because sparse-data bias or model instability may have influenced the estimate.

Body habitus was also associated with malnutrition. Compared with normal BMI, both underweight and severe obesity were independently associated with higher odds of malnutrition, suggesting a possible U-shaped relationship between BMI and nutritional risk. Underweight may reflect inadequate intake, reduced muscle mass, and PEW, whereas severe obesity may coexist with poor dietary quality, chronic inflammation, or sarcopenic obesity. These findings reinforce that nutritional risk in CKD cannot be assessed by body weight alone and that comprehensive nutritional screening is needed across all BMI categories [21-24]. However, the underweight subgroup was small, and this finding requires confirmation in larger studies.

Recent weight loss was independently associated with malnutrition, likely reflecting inadequate intake, inflammation, catabolic state, or progression of PEW. Increased weight during the previous four weeks was also associated with malnutrition, which may reflect fluid retention rather than true nutritional improvement, especially in advanced CKD. Reduced dietary intake was strongly associated with malnutrition, emphasizing the importance of routine dietary assessment in CKD care. Reduced intake may result from uremic symptoms, anorexia, dietary restrictions, gastrointestinal symptoms, depression, or functional limitation [2-5,25-27]. Impaired food accessibility was also associated with malnutrition, highlighting the role of social determinants, including food availability, caregiver support, financial constraints, and the ability to obtain and prepare appropriate meals.

Among laboratory parameters, higher serum creatinine was associated with increased odds of malnutrition, whereas higher lymphocyte percentage was associated with lower odds of malnutrition. These findings may reflect the combined effects of advanced kidney dysfunction, inflammation, immune dysregulation, and catabolic status [3-5]. Lymphocyte count may provide supportive information as an indirect marker of nutritional and immune status [28]. Although serum albumin is often used as a nutritional marker in CKD, the mean albumin level in this cohort remained relatively high despite a malnutrition prevalence of 39.3%. This may be explained by the multidimensional structure of the NAF, which captures recent weight change, dietary intake, functional status, and disease severity rather than relying only on biochemical markers. Serum albumin is also influenced by hydration, inflammation, hepatic synthesis, and protein losses, and recent evidence supports its role as a multifactorial biomarker rather than a standalone indicator of nutritional status [29]. Thus, normal albumin levels do not exclude malnutrition in pre-dialysis CKD [2,29].

This study has several strengths, including the relatively large cohort of patients with pre-dialysis CKD stages 3–5, the real-world tertiary-care setting, and the use of a validated nutritional screening tool developed for Thai populations. The study also evaluated demographic, clinical, nutritional, and laboratory factors simultaneously and identified a possible U-shaped association between BMI and malnutrition, which may be clinically useful for nutritional risk stratification. Several limitations, however, also should be acknowledged. The cross-sectional design prevents causal inference, and the single-center setting may limit generalizability. Nearly half of initially screened patients were excluded because of incomplete data, failure to meet eligibility criteria, or refusal to participate, which may have introduced selection bias. A formal comparison between included and excluded patients could not be performed because detailed data were not consistently available. Residual confounding from unmeasured factors, including inflammatory biomarkers, dietary quality, socioeconomic status, frailty, and physical performance, also cannot be excluded. In addition, incorporation bias is possible because several predictors were components of the NAF scoring system. Finally, the large effect estimate for stroke should be interpreted cautiously because of the small number of stroke cases and the possibility of sparse-data bias. Larger prospective multicenter studies with more comprehensive data collection are needed to confirm these findings and improve their generalizability.

Conclusion

Malnutrition was highly prevalent among patients with pre-dialysis CKD stages 3–5 and was independently associated with advanced CKD, underweight, severe obesity, stroke history, recent weight change, reduced dietary intake, impaired food accessibility, higher serum creatinine levels, and lower lymphocyte percentage. The present findings suggest a possible U-shaped association between body habitus and malnutrition, indicating that nutritional risk may exist at both extremes of BMI. However, because the underweight subgroup was small, this observation should be interpreted cautiously and warrants confirmation in larger prospective studies. Routine nutritional screening should therefore be implemented across all CKD stages regardless of body size to facilitate early identification of nutritional risk and appropriate nutritional management.

Ethics approval

The study protocol was approved by the Institutional Review Board of Rajavithi Hospital (Approval No. 213/2025). All procedures were conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to study enrollment.

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Competing interests

There were no identified potential conflicts of interest related to this article.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

Artificial intelligence (AI) tool, ChatGPT, was used solely for language editing and improvement of readability. All scientific content, interpretation of findings, and final manuscript approval were performed by the authors.

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