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Original Article

Correlation between cognitive impairment and body composition indicators in patients with chronic kidney disease after hemodialysis

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Abstract: Objective: To examine the relationship between cognitive impairment and body composition indicators in chronic kidney disease (CKD) patients post-hemodialysis. Methods: This retrospective study included 110 CKD patients admitted to Beijing Luhe Hospital, Capital Medical University between January 2019 and January 2023. General clinical data and body composition indicators were compared between patients with and without cognitive impairment. Multiple logistic regression and ROC curve analysis were used to identify influencing factors and to develop a predictive model. Results: Cognitive impairment occurred in 50% of the patients post-hemodialysis. No significant differences were found in demographics, disease duration, comorbidities, or hemodialysis duration between the groups (all $P > 0.05$). However, significant differences were observed in body mass index (BMI) ($P < 0.001$), lean body mass index (LTI) ($P = 0.007$), fat tissue index (FTI) ($P = 0.024$), and total body water (TBW) ($P < 0.001$). Multiple logistic regression identified TBW (OR 4.900, 95% CI 3.062-7.511, $P < 0.001$), the TBW/extracellular water (ECW) ratio (OR 7.244, 95% CI 5.092-8.7613, $P = 0.016$), and the ECW/body cell mass (BCM) ratio (OR 6.720, 95% CI 4.564-8.692, $P = 0.030$) as independent risk factors for cognitive impairment post-hemodialysis. ROC analysis confirmed their predictive capacity, with AUC values of 0.840, 0.840, and 0.850 respectively. A predictive model incorporating these indicators was developed, showing good calibration (Hosmer-Lemeshow test, $P = 0.912$) and discrimination (C-index 0.974, 95% CI 0.952-0.997). Conclusion: Total body water, the TBW/ECW ratio, and the ECW/BCM ratio are independently associated with cognitive impairment in CKD patients post-hemodialysis. Body composition analysis serves as a valuable tool for predicting cognitive impairment in this population, guiding clinicians in assessing cognitive function and planning interventions for these patients.

Keywords: Chronic kidney disease, hemodialysis, cognitive impairment, body composition analysis, prediction model

Introduction

Chronic kidney disease (CKD) is emerging as a significant global health challenge, with steadily increasing prevalence rates. The World Health Organization estimates that CKD affects over 50 million individuals worldwide [1]. Characterized by a gradual decline in renal function, CKD impairs the effective elimination of waste products and excess water from the body, severely compromising patients' quality of life and increasing the risk of cardiovascular events and mortality. Hemodialysis, a cornerstone intervention for CKD, plays a crucial role in maintaining electrolyte and acid-base balance by mechanically removing metabolic waste and excess fluid [2]. However, despite its essential role, hemodialysis has several drawbacks.

Recent studies have highlighted an increased risk of cognitive dysfunction following hemodialysis compared to individuals with CKD who do not undergo this treatment [3, 4]. Prolonged hemodialysis can lead to the accumulation of cerebral toxins, resulting in electrolyte imbal-

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ances, cognitive decline, deficits in concentration, and delayed reaction times. Cognitive function is critical in determining the outcomes of hemodialysis and its associated complications [5, 6]. Cognitive impairment, which lies between dementia and normal aging, poses a heightened risk of progressing to dementia as organ function declines, especially in elderly patients. Early detection and intervention are vital to mitigate the substantial impact on patients' quality of life.

Cognitive impairment, affecting essential faculties such as thinking, memory, and decision-making, significantly compromises patients' overall well-being. Studies consistently show a higher incidence of cognitive impairment following hemodialysis compared to CKD patients managed conservatively without dialysis [7, 8]. In a comprehensive study involving CKD patients, over 30% reported cognitive impairment symptoms after hemodialysis sessions [9]. Moreover, cognitive impairment is associated with reduced long-term survival rates and an increased occurrence of cardiovascular events. Thus, preventing cognitive impairment in CKD patients post-hemodialysis is of paramount clinical importance.

In individuals with kidney disease, significant changes in body composition analysis parameters are observed. Patients often show decreases in both body mass index (BMI) and lean tissue index (LTI) [10]. Additionally, an increase in fat tissue index (FTI) may be intricately linked to the patient's inflammatory status. Concurrently, alterations in total body water (TBW) and body cell mass (BCM) are closely associated with declining renal function [11]. These fluctuations in indicators reflect the physical condition and metabolic irregularities typical of CKD patients. Moreover, research has highlighted the connection between body composition parameters and clinical outcomes in CKD [12]. For instance, a study of CKD patients revealed a strong association between BMI, LTI, and survival rates [13]. Similarly, other studies have shown the relevance of the TBW/extracellular water (ECW) and ECW/BCM ratios to the inflammatory and nutritional status of patients [14]. Collectively, these findings underscore the importance of body composition analysis in assessing and managing CKD.

The correlation between body composition parameters and cognitive function is also notable. An increase in FT may be associated with cognitive decline, while abnormal changes in TBW, BCM, TBW/ECW, ECW/BCM, and ECW are linked to cognitive impairment. Existing studies further support this relationship [15, 16]. For example, research on elderly individuals has shown a significant association between BMI, LTI, and cognitive function [17]. Another study emphasized the importance of TBW/ECW and ECW/BCM ratios in cognitive decline [18]. These findings highlight the utility of body composition analysis in assessing and predicting cognitive function in individuals with CKD.

This study aims to explore the connection between cognitive impairment following hemodialysis in CKD patients and body composition parameters. The nomogram model, a widely used predictive tool in medical research, integrates various prognostic variables to provide a numerical probability of a specific clinical event, aligning with biological and clinical integration models to aid clinical decision-making. However, a tailored predictive model for cognitive impairment following hemodialysis in CKD patients is lacking. Therefore, this investigation examines the determinants of cognitive impairment post-hemodialysis and develops a predictive model to provide insights for clinical treatment and nursing practices.

Materials and methods

Study population and inclusion/exclusion criteria

This retrospective study involved 110 patients diagnosed with CKD, admitted to Beijing Luhe Hospital, Capital Medical University, between January 2019 and January 2023. Patients were divided into two groups based on their cognitive function as assessed by the Chinese version of the Montreal Cognitive Assessment: 55 patients with cognitive impairment (score < 26) and 55 patients without cognitive impairment (score ≥ 26). The inclusion criteria were as follows: 1. A confirmed diagnosis of CKD. 2. Undergoing hemodialysis for over 6 months. 3. Age over 18 years. 4. Availability of comprehensive clinical records. Exclusion criteria included: 1. Individuals with severe psychiatric disorders. 2. Patients diagnosed with malignancies. 3.

Those with neurodegenerative disorders such as Parkinson's disease. 4. Chronic alcohol dependence. 5. Patients with visual or auditory impairments. Approval for this research was obtained from the Ethics Committee of Beijing Luhe Hospital, Capital Medical University.

Methods

Data collection: Data collected at the time of patient admission included age, gender, disease duration, hypertension, diabetes, economic status, creatinine (Cr), blood urea nitrogen (BUN), serum albumin (ALB), hemoglobin (Hb), triglycerides (TG), total cholesterol (TC), and dialysis duration. A team of specialized healthcare professionals conducted data collection using pre-designed forms derived from the electronic medical record system. The data collection process adhered strictly to research ethics and regulations, ensuring the accuracy and integrity of the data.

Dialysis procedure: Prior to dialysis, an arteriovenous access was established to divert blood to the dialyzer for purification. All patients underwent standard bicarbonate hemodialysis with a blood flow rate of 245 mL/min and a dialysate flow rate of 500 mL/min. Each dialysis session lasted approximately 240 minutes.

Collection of body composition analysis indicators: The following body composition analysis indicators were collected: BMI: Calculated by measuring the patient's height and weight, expressed in kg/m^2. LTI: Calculated based on the measurement of lean body mass (excluding fat tissue), expressed in kg/m^2. FTI: Calculated based on the measurement of fat tissue weight, expressed in kg/m^2. TBW: Measured using bioelectrical impedance analysis or other methods to determine total body water content, expressed in liters (L). BCM: Measured using bioelectrical impedance analysis or other methods to determine BCM, expressed in kilograms (kg). TBW/ECW Ratio: Calculated by dividing TBW by ECW. ECW/BCM Ratio: Calculated by dividing ECW by BCM. ECW: Measured using specialized body composition analysis instruments.

All the above indicators were measured using bioelectrical impedance analysis instruments.

Cognitive function assessment

The Chinese version of the Montreal Cognitive Assessment was used to assess the cognitive function of the patients. The total possible score was 30 points, with a score of ≥ 26 points considered indicative of normal cognitive function. The cognitive function assessment was conducted after a minimum of six months of hemodialysis treatment.

Statistical analysis

Means, standard deviations, and quartile ranges were calculated for all continuous variables, while frequency counts and percentages were calculated for categorical variables. For continuous variables that followed a normal distribution, independent sample t-tests or one-way analysis of variance (ANOVA) were used. For continuous variables that did not follow a normal distribution, Mann-Whitney U tests were applied. Chi-square or Fisher's exact test was used for analyzing categorical variables.

In the univariate logistic regression analysis, variables with a *p*-value of less than 0.1 were included in the final multivariate analysis. Based on the results of the multivariate logistic regression, a nomogram was constructed using the rms package in R software. The discriminatory performance of the nomogram was evaluated using the c-index, an alternative measure of the area under the ROC curve. Model calibration was assessed with the Hosmer-Lemeshow goodness-of-fit test, where non-significant values indicated good model calibration. A calibration plot was generated to visually assess the agreement between predicted and actual risks.

Internal validation and calibration of the model were performed using 1,000 bootstrap resamples. Decision curve analysis (DCA) was conducted using the rmda package to determine the clinical utility of the nomogram in predicting cognitive impairment risk. DCA helps quantify the net benefit of the predictive model in clinical decision-making.

In addition to standard statistical tests, a nomogram was developed to predict the risk of cognitive impairment in CKD patients post-hemodialysis. The nomogram was based on multivariable logistic regression analysis, incorporating variables identified as significant predictors. The calibration of the nomogram was performed using the bootstrap resampling method, and its discrimination ability was evaluated using the C-statistic (area under the ROC curve, AUC). Finally, the clinical utility of the

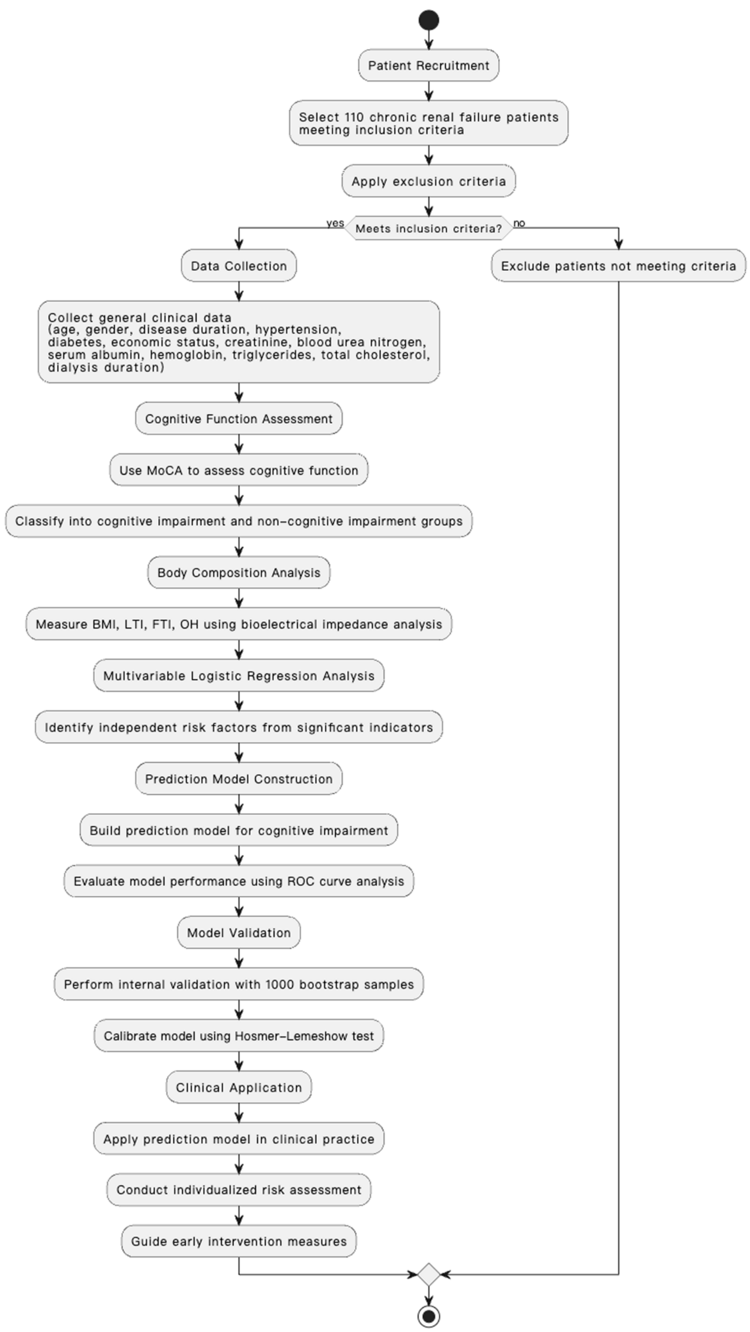

Figure 1. Research process diagram. Montreal Cognitive Assessment (MoCA), body mass index (BMI), lean body mass index (LTI), fat weight index (FTI), total body water (TBW).

nomogram was assessed by calculating the net benefit at various risk thresholds using DCA. This comprehensive evaluation ensures that the nomogram not only predicts cognitive impairment risk accurately but also holds practical value in clinical settings. All analyses were performed using R version 3.6.3 and SPSS version 26.0 for Mac. Statistical significance was determined with a threshold of $P < 0.05$ for all analyses. The overall research process is illustrated in **Figure 1**.

Results

General patient characteristics

The average age of the cohort was 65.21 years, with 71 male patients, representing 64.5% of the total. Cognitive impairment was observed in 50 patients post-hemodialysis, accounting for 45.5% of the cohort. Comprehensive patient details are provided in **Table 1**.

Comparison of general clinical data

The study enrolled 110 patients with CKD, who were stratified into two groups based on the presence of cognitive impairment post-hemodialysis. There were no statistically significant differences between the groups in terms of age, gender distribution, disease duration, presence of hypertension or diabetes, socioeconomic status, Cr, BUN, ALB, Hb, TG, TC levels, and dialysis duration (all $P > 0.05$). Detailed comparative data are presented in **Table 2**.

Comparison of body composition analysis indicators between the two groups

The differences in body composition analysis indicators between the two groups are shown in **Table 3**. Significant differences were observed between the two groups across several characteristics. The BMI of the group without cognitive impairment was 23.124 ± 1.1122 kg/m^2, significantly higher than the 22.076 ± 1.113 kg/m^2 in the group with cognitive impairment ($P < 0.001$). The lean tissue index (LTI) was 13.15 ± 2.2151 kg/m^2 in the group without cognitive impairment, com-

Table 1. Basic clinical information of included patients

Characteristics	Overall
Age (years), mean ± sd	65.209 ± 5.1919
Gender [(%)], n (%)	
Male	71 (64.5%)
Female	39 (35.5%)
Disease duration (years), mean ± sd	4.525 ± 0.55478
Hypertension [(%)], n (%)	
Yes	50 (45.5%)
No	60 (54.5%)
Diabetes [(%)], n (%)	
Yes	38 (34.5%)
No	72 (65.5%)
Economic status [(%)], n (%)	
Good	56 (50.9%)
Poor	54 (49.1%)
Cr (μmol/L), mean ± sd	41.245 ± 6.2137
BUN (mmol/L), mean ± sd	22.545 ± 3.1063
ALB (g/L), mean ± sd	40.215 ± 2.5458
Hb (g/L), mean ± sd	102.54 ± 11.524
TG (mmol/L), mean ± sd	2.8845 ± 0.54959
TC (mmol/L), mean ± sd	6.2155 ± 0.53607
Dialysis time (months), mean ± sd	28.215 ± 4.2081
Cognitive impairment, n (%)	
Group without cognitive impairment	55 (50%)
Group with cognitive impairment	55 (50%)

Economic status, creatinine (Cr), blood urea nitrogen (BUN), serum albumin (ALB), hemoglobin (Hb), triglycerides (TG), total cholesterol (TC).

pared to 11.949 ± 2.3794 kg/m^2 in the group with cognitive impairment (P = 0.007). For the fat tissue index (FTI), the group without cognitive impairment had a value of 10.355 ± 2.1112 kg/m^2, higher than the 9.5455 ± 1.5514 kg/m^2 in the group with cognitive impairment (P = 0.024).

In terms of TBW, the average value in the group without cognitive impairment was 2.5055 ± 0.54515 L, significantly lower than the 4.1055 ± 1.0573 L in the group with cognitive impairment (P < 0.001). There was no significant difference in ECW between the two groups (P = 0.109). The BCM was 14.615 ± 2.5544 kg in the group without cognitive impairment, significantly higher than the 12.216 ± 2.5528 kg in the group with cognitive impairment (P < 0.001). The TBW/ECW ratio in the group without cognitive impairment was 0.21491 ± 0.093212, significantly lower than the 0.34836 ± 0.097273 in the group with cognitive impairment (P < 0.001). The ECW/BCM ratio in the group without cognitive impairment was 1.0149 ± 0.27491 L/kg, significantly lower than the 1.4149 ± 0.26648 L/kg in the group with cognitive impairment (P < 0.001).

Multivariable logistic regression analysis of factors influencing cognitive impairment

Cognitive impairment was used as the dependent variable, and the factors identified through univariate analysis (BMI, LTI, FTI, TBW, BCM, TBW/ECW, ECW/BCM) were used as independent variables for multivariable logistic regression analysis. The results, presented in **Table 4**, indicate that TBW, TBW/ECW, and ECW/BCM are independent risk factors for cognitive impairment in patients with CKD after hemodialysis (all P < 0.05).

ROC analysis of body composition analysis indicators for predicting cognitive impairment after hemodialysis in patients with CKD

ROC curve analysis was performed on the significant quantitative variables (BMI, LTI, FTI, TBW, BCM, TBW/ECW, ECW/BCM) to predict cognitive impairment after hemodialysis in patients with CKD. The results showed that the area under the ROC curve (AUC) was 0.741, 0.635, 0.639, 0.840, 0.783, 0.840, and 0.85, respectively (**Figure 2**).

Construction of risk prediction line chart model for cognitive impairment after hemodialysis in patients with CKD

Based on the three independent risk factors identified through multivariable logistic regression, a predictive model for cognitive impairment after hemodialysis was constructed (**Figure 3**). These three independent predictors were assigned scores ranging from 0 to 100, and the total score was then converted into an individual probability of developing cognitive impairment after hemodialysis.

Validation of the line chart model

Internal validation was performed using the bootstrapping technique with 1,000 samples.

Table 2. Comparison of general clinical data

Characteristics	Group without cognitive impairment	Group with cognitive impairment	*P* value
N	55	55	
Age (years), mean ± sd	65.691 ± 5.4734	64.727 ± 4.8969	0.333
Gender [(%)], n (%)			0.550
Male	37 (67.3%)	34 (61.8%)	
Female	18 (32.7%)	21 (38.2%)	
Disease duration (years), mean ± sd	4.5735 ± 0.5541	4.4765 ± 0.55628	0.362
Hypertension [(%)], n (%)	23 (41.8%)	27 (49.1%)	0.444
Diabetes [(%)], n (%)	18 (32.7%)	20 (36.4%)	0.688
Economic status [(%)], n (%)			0.703
Good	29 (52.7%)	27 (49.1%)	
Poor	26 (47.3%)	28 (50.9%)	
Cr (μmol/L), mean ± sd	40.46 ± 5.6996	42.029 ± 6.6479	0.187
BUN (mmol/L), mean ± sd	22.558 ± 2.9468	22.531 ± 3.2853	0.964
ALB (g/L), mean ± sd	40.378 ± 2.2661	40.051 ± 2.8093	0.503
Hb (g/L), mean ± sd	101.85 ± 12.023	103.22 ± 11.071	0.535
TG (mmol/L), mean ± sd	2.9109 ± 0.53978	2.8582 ± 0.56296	0.617
TC (mmol/L), mean ± sd	6.2382 ± 0.56585	6.1927 ± 0.50876	0.659
Dialysis time (months), mean ± sd	27.584 ± 4.0854	28.845 ± 4.2711	0.116

Economic status, creatinine (Cr), blood urea nitrogen (BUN), serum albumin (ALB), hemoglobin (Hb), triglycerides (TG), total cholesterol (TC).

Table 3. Comparison of body composition analysis indicators between the two groups

Characteristics	Group without cognitive impairment	Group with cognitive impairment	*P* value
N	55	55	
BMI (kg/m^2), mean ± sd	23.124 ± 1.1122	22.076 ± 1.113	< 0.001
LTI (kg/m^2), mean ± sd	13.15 ± 2.2151	11.949 ± 2.3794	0.007
FTI (kg/m^2), mean ± sd	10.355 ± 2.1112	9.5455 ± 1.5514	0.024
TBW (L), mean ± sd	2.5055 ± 0.54515	4.1055 ± 1.0573	< 0.001
ECW (L), mean ± sd	15.004 ± 2.1621	14.225 ± 2.8457	0.109
BCM (kg), mean ± sd	14.615 ± 2.5544	12.216 ± 2.5528	< 0.001
TBW/ECW, mean ± sd	0.21491 ± 0.093212	0.34836 ± 0.097273	< 0.001
ECW/BCM (L/kg), mean ± sd	1.0149 ± 0.27491	1.4149 ± 0.26648	< 0.001

Body mass index (BMI), lean body mass index (LTI), fat weight index (FTI), total body water (TBW), body cell mass (BCM), extracellular water (ECW).

The results, shown in **Figure 4**, indicate that the Harrell C-Index was 0.974 (95% CI: 0.952-0.997), suggesting good calibration of the model. The Hosmer-Lemeshow test yielded a chi-square value of 3.327 with a *P*-value of 0.912, indicating good predictive accuracy. As shown in **Figure 5**, the ROC of the predictive model was 0.974 (95% CI: 0.952-0.996), demonstrating good discrimination. According to the results in **Figure 6**, the model exhibited strong clinical predictive performance.

Discussion

Patients with CKD, facing progressive deterioration, often experience systemic dysfunction affecting both physical and mental health. While hemodialysis is a cornerstone of their clinical care, it also poses potential risks for cognitive decline. Recent epidemiological studies have explored post-hemodialysis cognitive impairment in this patient cohort, investigating contributing factors. Some research suggests

Table 4. Multivariable logistic regression analysis of factors associated with cognitive impairment after hemodialysis in patients with chronic kidney disease

Characteristics	Total (N)	Multivariate analysis	
		Odds Ratio (95% CI)	*P* value
BMI (kg/m^2)	110	0.504 (0.217-1.173)	0.112
LTI (kg/m^2)	110	1.087 (0.712-1.660)	0.698
FTI (kg/m^2)	110	0.856 (0.499-1.468)	0.572
TBW (L)	110	4.900 (3.062-7.511)	< 0.001
BCM (kg)	110	0.829 (0.584-1.175)	0.291
TBW/ECW	110	7.244 (5.092-8.7613)	0.016
ECW/BCM (L/kg)	110	6.720 (4.564-8.692)	0.030

Body mass index (BMI), lean body mass index (LTI), fat weight index (FTI), total body water (TBW), body cell mass (BCM), extracellular water (ECW).

that disease progression plays a pivotal role, with complications arising from prolonged illness duration and its complex interplay with patients' psychological well-being. However, consensus on this matter remains elusive [19, 20].

Our study takes a novel approach by constructing a predictive model for post-hemodialysis cognitive impairment in CKD patients, leveraging indicators from body composition analysis. Traditional predictive models have predominantly focused on clinical and biochemical markers, often overlooking the potential impact of patients' body composition and metabolic status on cognitive function. Body composition analysis provides a more holistic insight into patients' physiological makeup and metabolic status, thereby enhancing predictive accuracy. The significance of this predictive model lies in its ability to offer precise and personalized risk assessments. Through quantitative analysis of body composition, clinicians can gain a deeper understanding of patients' physical condition and metabolic status, facilitating targeted interventions for the early detection and management of cognitive impairment [21, 22]. Furthermore, implementing this predictive model empowers clinicians to effectively evaluate treatment outcomes and prognosis, guiding the formulation of tailored treatment and management strategies.

Body composition analysis serves as a crucial tool for evaluating the distribution and composition of tissues and organs in patients. Our findings revealed notable discrepancies in body composition analysis indicators between CKD patients with cognitive impairment after hemodialysis and those without cognitive impairment. Specifically, the cognitive impairment group exhibited significant differences in BMI, LTI, FTI, TBW, ECW, BCM, TBW/ECW ratio, and ECW/BCM ratio compared to the non-cognitive impairment group. These results suggest a potential association between body composition analysis indicators and the onset of cognitive impairment post-hemodialysis in CKD patients. Quantitative analysis of body composition offers an objective and precise method for predicting cognitive impairment. Unlike traditional clinical markers, body composition analysis provides a comprehensive assessment of the patient's physiological composition and metabolic status, opening new avenues for the early detection and intervention of cognitive impairment. Moreover, establishing this predictive model equips clinicians with a straightforward, rapid, and viable tool to assess the risk of cognitive impairment in patients and informs about individualized treatment and management strategies.

This investigation employed multiple logistic regression analysis to identify independent risk factors for cognitive impairment following hemodialysis in patients with CKD. The findings revealed that TBW, the TBW/ECW ratio, and the ECW/BCM ratio are independent risk factors for cognitive impairment in this patient population. TBW represents the excess water content within bodily tissues compared to normal levels and can partly reflect volume overload in individuals with kidney failure [23, 24]. Clinically, a TBW range of -1 to 1 L is considered normal. The TBW/ECW ratio indicates the proportion of TBW to ECW, while the ECW/BCM ratio reflects the balance between ECW and BCM. These indicators provide insight into a patient's fluid balance and the distribution of intracellular and extracellular fluids [25].

The study identified a strong association between increased TBW, elevated TBW/ECW ratio, heightened ECW/BCM ratio, and the onset of cognitive impairment following hemodialysis in CKD patients, as compared to those with CKD who do not undergo hemodialysis [26].

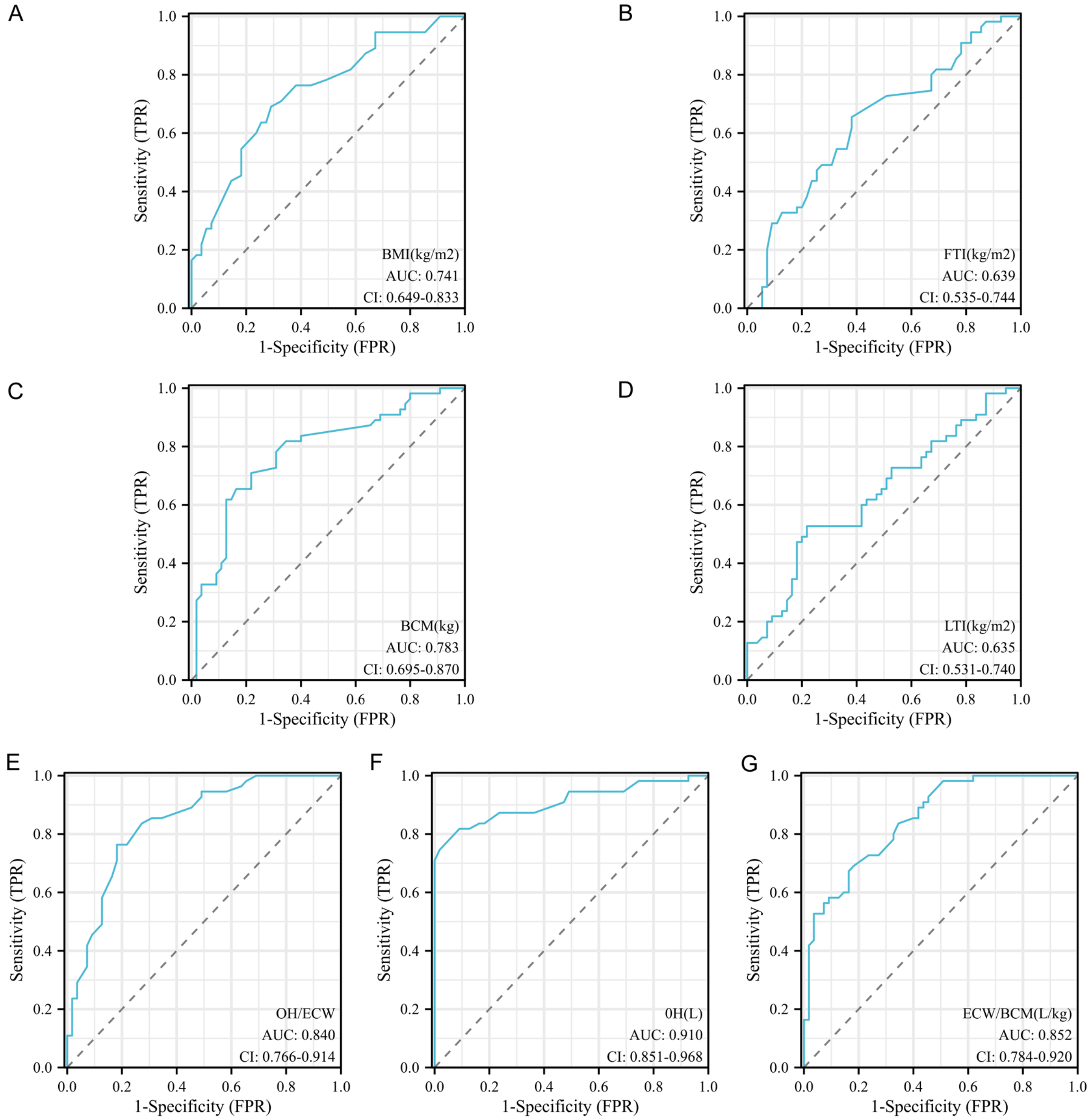

Figure 2. ROC analysis of body composition analysis indicators for predicting cognitive impairment after hemodialysis in patients with chronic kidney disease. A. BMI. B. FTI. C. BCM. D. LTI. E. TBW/ECW. F. TBW. G. ECW/BCM. Body mass index (BMI), lean body mass index (LTI), fat weight index (FTI), total body water (TBW), body cell mass (BCM), extracellular water (ECW).

The findings also suggest that fluid and electrolyte imbalances frequently experienced by these patients post-hemodialysis may significantly contribute to cognitive impairment [27]. Hemodialysis has the potential to disrupt fluid balance, leading to increased TBW and accumulation of ECW. These fluid imbalances could result in brain cell edema and neurological function impairment, ultimately contributing to cognitive decline. Furthermore, the elevated ECW/BCM ratio may be associated with the development of cognitive impairment [28]. The accumulation of ECW can disrupt the equilibrium between intracellular and extracellular fluids, affecting the stability of the intracellular environment and the normal functioning of nerve cells. This imbalance may represent a critical mechanism underlying cognitive impairment.

One major limitation of this study is the absence of cognitive function assessment before hemo-

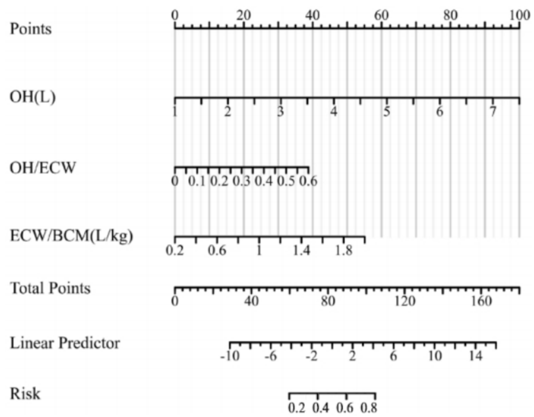

Figure 3. Predictive nomogram model based on multivariable logistic regression analysis to determine independent risk factors for predicting cognitive impairment after hemodialysis.

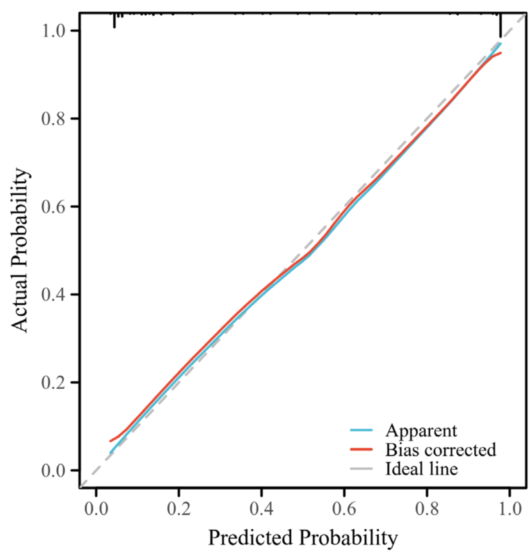

Figure 4. Calibration curve of the nomogram model.

dialysis. This limitation makes it difficult to determine whether the cognitive impairment observed post-hemodialysis is a direct result of the treatment or if it was already present at a similar level prior to the initiation of hemodialysis. Without baseline cognitive function data, the study cannot conclusively establish a causal relationship between hemodialysis and cognitive decline. This limitation may affect the interpretation of the results and the strength of the conclusions drawn. Future research should address this by incorporating pre-hemodialysis cognitive assessments to provide a clearer picture of cognitive changes over the course of hemodialysis treatment. Such an approach

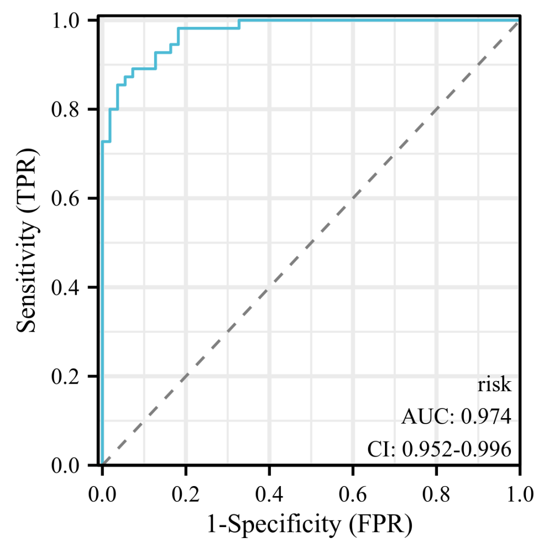

Figure 5. ROC curve of the nomogram model.

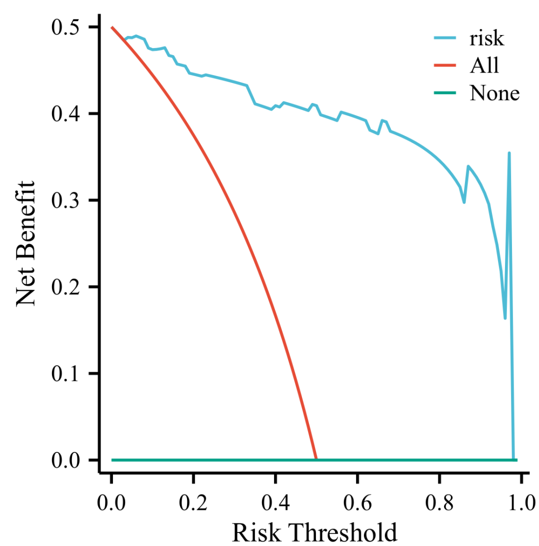

Figure 6. Decision curve analysis of the nomogram model.

would help in distinguishing the effects of hemodialysis on cognitive function more accurately and enhance the validity of the predictive model for cognitive impairment. Longitudinal studies with repeated cognitive assessments over time would be beneficial to track the trajectory of cognitive changes in CKD patients undergoing hemodialysis.

Additionally, this study is a single-center investigation with a relatively small sample size, potentially introducing selection bias. Future multicenter studies could enhance the reliability and generalizability of the findings. The study also focused solely on the relationship between body composition analysis indicators and cognitive impairment following hemodialysis, without considering other potential influencing factors such as inflammatory markers and vascular function. Subsequent research should further explore these aspects.

In summary, this study highlights a correlation between body composition analysis indicators and cognitive impairment post-hemodialysis in patients with CKD. TBW, the TBW/ECW ratio, and the ECW/BCM ratio are independent risk factors. These findings hold clinical significance for the prevention and management of cognitive impairment following hemodialysis in patients with CKD.

Disclosure of conflict of interest

None.

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