Correlation Analysis of Cognitive Impairment And Malnutrition In Elderly Patients With Chronic Heart Failure

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Abstract

Aims: The purpose of this study was to evaluate the correlation between cognitive impairment (CI) and malnutrition in elderly patients with chronic heart failure (CHF) and to determine the relationship between different nutritional indexes and cognitive impairment in patients with chronic heart failure.

Methods and results: We examined the correlation between CI and nutritional indicators in elderly hospitalized patients with CHF. The nutritional status of patients was evaluated by Mini Nutritional Assessment（MNA), anthropometric assessment indicators, human component analysis indicators and laboratory tests indicators. Use of the Min-mental state examinatsion (MMSE) to evaluate cognitive function. The study included 184 heart failure patients aged 60 or older. According to the international common cognitive function assessment scale, the patients were divided into CI group and not CI group. In terms of nutrition, compared with those without CI, patients with CI had lower MNA score, Body mass index (BMI), arm circumference, calf circumference, fat free mass, upper arm muscle circumference, lymphocytes absolute value, hemoglobin, hematocrit, albumin, prealbumin, and cholesterol ($P < 0.001$). Among them, albumin (odds ratio [OR]=0.767, $P < 0.05$), arm circumference (odds ratio [OR]=0.614; $P < 0.05$), MNA score (odds ratio [OR]=0.675; $P < 0.001$) was significantly correlated with CI in elderly patients with CHF, and We found that the AUC was the largest when the three indexes were combined to draw the ROC curve (AUC: 0.935).

Conclusions: Our findings emphasize that malnutrition is common in the elderly population, and that it is strongly associated with cognitive decline. Identifying and treating malnutrition is essential for all older people.

1. Introduction

Heart Failure (HF) is a disease of increasing prevalence worldwide, with an estimated 37.7 million people worldwide suffering from it[1]. Recent research trends show that the prevalence of HF increases with age, with more than 10 percent of patients aged 70 or older[2]. The prevalence of HF is anticipated to double in the next 40 years due to an aging population and improved survival rates from coronary artery disease[3]. An important health problem of patients with HF is CI. According to recent studies[4, 5], about 73-80% of patients with HF have CI due to HF, which may be related to chronic or intermittent cerebral perfusion insufficiency and changes in cerebrovascular activity caused by HF[6, 7]. CI in patients with HF is usually manifested as attention deficit, decreased executive function, slower processing speed and memory loss[8, 9]. The causes of cognitive impairment in patients with heart failure are still unclear, and may be related to the mechanisms of altered cerebral blood perfusion, arterial hypotension, anemia, chronic kidney disease, and low left ventricular ejection fraction[10]. Recent studies have shown that vascular problems, such as cerebral hypoperfusion, cause neuronal damage and gray matter loss in brain regions. These neurons and gray matter are vital to cognitive function, which has been identified as an independent predictor of HF endpoint events. Cognitive function is very significant in assessing the severity of HF, second only to the severity of HF[11].

Nutritional status plays an essential role in the development of HF and may affect cognitive function either directly or indirectly through its influence on the progression of HF[12]. With the aging of the society, the number of patients with HF is increasing, and such elderly patients are prone to malnutrition, reduced ability of daily living, sarcopenia and cognitive decline. Some studies have also reported that malnutrition is related to CI[13, 14]. The effects of nutrition on cognitive health may be related to mechanisms such as oxidative stress, low systemic inflammation, neuroinflammation and autophagy changes (associated with obesity, metabolic syndrome and insulin resistance)[15]. However, few studies have been conducted to examine whether there is an association between the effect of nutritional status on cognitive function and HF. Currently, although risk factors associated with CI in patients with CHF are common, they are not well understood. So identifying reversible or modifiable factors of CI should be a research priority. To achieve this goal, we studied the elderly population with CHF. The purpose of this study was to study the correlation analysis between CI and malnutrition in elderly patients with CHF, and to identify the relationship between different nutritional indexes and cognitive impairment in patients with chronic heart failure.

2. Materials And Methods

2.1. Study Design and Sample

This study utilized a cross-sectional study design. A population of 184 elderly patients with CHF who were hospitalized in the cadre ward of the First Hospital of Jilin University was selected. The duration of hospitalization of these patients was limited to January 20, 2021 to October 20, 2021. CHF is a diagnosis of HF by echocardiography, clinical history, symptoms, and the history is more than 6 months. Participants were hospitalized patients 60 years of age or older with a diagnosis of CHF. The exclusion criteria were patients' refusal to accept the Comprehensive Geriatric Assessment Questionnaire. Patients unable to cooperate with the completion of the research contents, such as consciousness disorders, deafness, aphasia; Diabetic patients; Alzheimer's disease; dementia after cerebrovascular disease were clearly diagnosed; Patients with dementia caused by neurodegenerative diseases; Lack of basic data or laboratory indicators; Use of glucocorticoids within the past 1 year; Bedridden for a long time, unable to eat through the mouth; Current or previous malignancies, immune system disorders, severe liver and kidney dysfunction and other serious medical conditions. There were 208 inpatients were definitively diagnosed with CHF, of which 17 did not meet the inclusion criteria, 3 patients had missing laboratory indicators, and 4 others refused to participate, and 184 inpatients participated and completed the survey.

2.2. Measurements

2.2.1. Socio-Demographic and general information

Sociodemographic characteristics, including age, sex, and education, were assessed using a self-made face-to-face interview questionnaire. Physical indicators included height, weight, body mass index, waist circumference, arm circumference and calf circumference, which were routine examination items on the day of admission. Clinical information was gathered from electronic medical records, including smoking history, drinking history, hemoglobin(HB), hematocrit (HCT) and lymphocyte absolute value, aspartate transaminase, alanine transaminase, alkaline phosphatase, albumin, prealbumin, Blood urea nitrogen (BUN), creatinine, uric acid, retinol binding protein, inhibition C, Estimated Glomerular Filtration Rate (eGFR), cholesterol, triglyceride, low density lipoprotein cholesterol, high-density lipoprotein cholesterol, left atrial diameter, left ventricular end diastolic diameter.

Nutrition measures included: Body mass index (BMI), waist circumference, arm circumference, calf circumference, fat free mass, upper arm muscle dimension, serum albumin, prealbumin, lymphocyte absolute value, cholesterol, triglyceride, low density lipoprotein cholesterol, and high-density lipoprotein cholesterol.

2.2.2. Body Composition Analysis

The body composition of the patients was measured by Bioelectrical Impedience Analysis (BIA) using the Inbody S10 device (Biospace, Seoul, Korea)[16]. All patients were supine for 10 minutes before analysis. In the analysis, the patients were supine with arms abduction of 15°, starting from the torso and legs separated shoulder-width apart. Eight electrodes were placed between the hands (thumbs and middle fingers) and between the ankles and heels of the patients. Alcohol was applied to clean the skin before placing the electrodes to reduce skin contact resistance. The patient's age, gender, height and weight were input to measure the patient's fat free mass, visceral fat area and upper arm muscle dimension. The measurement process in this study was completed by the same physician in the cadre ward department of the First Hospital of Jilin University.

2.2.3. Cognitive Function

The Min-Mental State Examinatsion (MMSE) is the psychometric screening tool most frequently administered to assess cognitive function. It is a straightforward and rapid test that can be applied by any clinician to assess overall cognitive functioning, and is especially used extensively in primary assessments[17]. The MMSE consists of 30 items, surveying five areas, including direction, registration, attention and calculation, recall and language. The MMSE score ranges from 0 to 30, and the lower the score, the worse the cognitive function[18]. In this study, we classified the boundary of cognitive normality according to the level of education into primary school education > 20 points, junior high school or above > 24 points, below which was defined as cognitive dysfunction[19].

2.2.4. Malnutrition

Nutritional status was comprehensively assessed by multiple indicators, including clinical assessment, dietary history, anthropometric assessment, and laboratory examination results assessment[20]. We through the use of Mini Nutritional Assessment(MNA), anthropometric assessment indicators (such as BMI, waist circumference, arm circumference, calf circumference) and body composition analysis indicators（such as fat free mass, upper arm muscle dimension) and laboratory indexes（such as serum albumin, prealbumin, lymphocyte absolute value, cholesterol, triglyceride, low density lipoprotein cholesterol, high-density lipoprotein cholesterol) to comprehensive evaluate the Nutritional status of patients. MNA is the most mature nutrition screening and assessment tool for the elderly, and also a good prognostic tool for the detection of malnutrition. MNA, developed in 1994 and patented by Nestle, is an assessment tool specifically designed for the elderly to assess malnutrition[21]. The test has four parts: anthropometric, holistic assessment, dietary questionnaire and subjective assessment. Subjects with an MNA score greater than or equal to 24 were nutritionally normal, while those with an MNA score less than or equal to 17 were classified as malnourished; Subjects with an MNA score between 17 and 24 are at risk of malnutrition[20].

2.3. Data Analysis

Statistical analysis was performed using SPSS/ Win 23.0 software (IBM, Armonk, NY, USA). Continuous variables were analyzed using means and standard deviations, and categorical variables were analyzed using percentages. The chi-square test was used to describe the prevalence of CI according to the characteristics of the patients. The prevalence of malnutrition based on patients' cognitive status was calculated by independent t-test and chi-square test. In order to determine the impact of malnutrition on CI in elderly patients with CHF, after adjusting for confounding factors, multivariate Logistic regression analysis was used to observe OR value and 95% confidence interval. By drawing ROC curve and calculating AUC value, The relationship between different nutritional indexes and cognitive impairment in patients with chronic heart failure was determined. A P value less than 0.05 was considered statistically significant.

3. Results

3.1 General baseline characteristics of elderly patients with CHF patients with and without CI (n = 184).

The baseline clinical characteristics of the patients were shown in Table 1. A total of 184 participants took part in the study. The mean age of the subjects was 78.23(±9.72)years old, and the age difference was statistically significant ($P < 0.001$). Sixty-five subjects (35.3%) were diagnosed with CI by MMSE score, with a mean MMSE score of 21.86（±2.76）. Patients with CI had older age and lower educational level than patients without CI. In addition, compared with patients without CI, patients with CI had lower Alanine transaminase, eGFR, MMSE, and higher blood urea nitrogen and left atrial diameter ($P < 0.05$), and the difference was statistically significant (Table 1).

Table 1
General baseline characteristics of elderly patients with CHF without CI.

	All	Without CI(n=119)	With CI(n=65)	P
	n(%)or Mean±SD	n(%)or Mean±SD	n(%)or Mean±SD	
Age (years)	78.23±9.72	74.81±9.48	84.49±6.52	<0.001 *
Sex (men), n (%)	54(29.35%)	33(27.73%)	21(32.31%)	0.515
Education ≥ Middle School	172(93.48%)	115(96.64%)	57(87.69%)	0.019*
Smoking history	113(61.41%)	76(63.87%)	37(56.92%)	0.355
Drinking history	121(65.76%)	83(69.75%)	38(58.46%)	0.123
AST(U/L)	21.64±8.94	21.62±8.82	21.69±9.22	0.957
ALT (U/L)	18.87±11.48	20.52±12.15	15.84±9.51	0.008*
ALP(U/L)	67.53±21.09	66.95±22.17	68.60±19.09	0.612
BUN (mmmol/L)	6.35±1.95	6.13±1.88	6.76±2.04	0.036*
Scr(ummol/L)	79.73±22.22	78.23±20.97	82.48±24.28	0.236
UA(ummol/L)	337.92±93.16	335.29±94.50	342.75±91.18	0.605
Cys-C(mg/L)	1.29±0.40	1.27±0.41	1.33±0.38	0.320
RBP(mg/L)	39.76±11.60	40.87±11.67	37.74±11.30	0.081
eGFR (mL/min)	71.31±17.75	75.00±17.38	64.55±16.48	<0.001 *
LAD(cm)	37.68±5.56	37.02±4.92	38.91±6.41	0.027*
LVEDD(cm)	45.45±4.02	45.42±4.08	45.51±3.95	0.888
MMSE(scores)	25.79±3.52	27.93±1.38	21.86±2.76	<0.001 *

*Significantly different.

3.2 Comparison of nutrition-related indicators in elderly patients with CHF with and without CI.

In terms of nutrition, patients with CI had lower MNA scores than those without CI, with lower BMI, upper arm circumference, lower leg circumference, fat free mass, upper arm muscle circumference, lymphocyte absolute value, hemoglobin, hematocrit, albumin, prealbumin and cholesterol, and the difference was statistically significant ($P < 0.05$).

Table 2

Comparison of nutrition-related indicators such as laboratory tests, body measurements, and human component analysis in elderly patients with CHF without CI.

	All	Without CI(n=119)	With CI(n=65)	P
	n(%)or Mean±SD	n(%)or Mean±SD	n(%)or Mean±SD	
BMI (kg/m2)	24.31±3.22	25.08±3.32	22.89±2.48	<0.001 *
WC(cm)	88.48±9.20	88.95±9.06	87.62±9.46	0.353
AC(cm)	26.52±2.49	27.40±2.22	24.89±2.13	<0.001 *
CC(cm)	31.40±3.05	32.09±3.03	30.13±2.67	<0.001 *
FFM(kg)	46.75±7.85	48.70±7.81	43.19±6.60	<0.001 *
MAMC(cm)	21.68±2.27	22.22±2.43	20.71±1.54	<0.001 *
VFA(cm2)	83.29±34.78	81.47±34.64	86.64±35.05	0.337
Hb (g/L)	132.96±19.03	138.38±17.63	123.05±17.57	<0.001 *
HCT(L /L)	0.39±0.05	0.41±0.05	0.36±0.05	<0.001 *
LY#(109/L)	1.66±0.55	1.77±0.51	1.46±0.57	<0.001 *
Alb(g/L)	37.89±4.13	39.37±3.85	35.19±3.19	<0.001 *
Prealbumin (g/L)	0.23±0.08	0.24±0.05	0.20±0.10	0.003
Cholesterol(mmmol/L)	4.41±1.01	4.52±0.94	4.20±1.10	0.037*
Triglyceride(mmmol/L)	1.48±1.18	1.58±1.13	1.30±1.26	0.112
LDL-C(mmmol/L)	2.78±0.83	2.86±0.80	2.63±0.86	0.075
HDL-C (mmmol/L)	1.14±0.29	1.14±0.25	1.14±0.34	0.971
MNA (scores)	21.10±3.74	22.78±2.76	18.02±3.31	<0.001 *
*Significantly different.				

3.3 Prevalence of CI in different nutritional states.

Prevalence of CI in elderly patients with CHF was listed according to different nutritional status. The results showed that there were significant differences in nutritional status between the CI group and the not CI group. The prevalence of CI was significantly higher in malnourished patients (n= 41,87.8%) than in well-nourished or risk of malnutrition patients (*P* <0.001). Data show that patients with CHF are at increased risk of malnutrition (n= 97,52.7%) (Table 3).

Table 3
Prevalence of CI in different nutritional states.

Nutrition status	Without CI	With CI	*P*
well-nourished	43(36.1%)	3(4.6%)	
risk of malnutrition	71(59.7%)	26(40.0%)[a]	<0.001 *
malnourished	5(4.2%)	36(55.4%)[ab]	

[a] Comparison between the well-nourished group and the group at risk of malnutrition, P=0.004;The comparison between the well-nourished group and the malnourished group was $P < 0.001$.

[b] Comparison between the well-nourished group and the group at risk of malnutrition, P<0.001.

*Significantly different.

3.4 Logistic regression analyss of risk factors for CI in elderly patients with CHF.

Table 4 summarizes a logistic regression analysis of risk factors for CI in elderly patients with CHF. This analysis showed that the upper arm circumference level (odds ratio [OR]=0.614; $P < 0.05$) and albumin (odds ratio [OR]=0.767, $P < 0.05$) were significant protective agents for CI. MNA score (odds ratio [OR]=0.675; $P < 0.001$) indicating that malnutrition is an significant risk factor for CI.

Table 4
Logistic regression analysis of risk factors for CI in elderly patients with CHF.

Indicators	B	BE	Wald	OR	95%CI	P
BMI	-0.194	0.137	1.983	0.824	(0.629-1.079)	0.159
AC	-0.487	0.209	5.445	0.614	(0.408-0.925)	0.020
MAMC	0.285	0.160	3.172	1.330	(0.972-1.820)	0.075
Hb	0.037	0.065	0.321	1.038	(0.913-1.179)	0.571
Alb	-0.266	0.104	6.534	0.767	(0.625-0.940)	0.011
MNA	-0.393	0.096	16.961	0.675	(0.560-0.814)	<0.001

The dependent variable was the presence of cognitive impairment, and the covariables included age, educational background, alanine aminotransferase, urea, BMI, EGFR, left atrial diameter, upper arm circumference, lower leg circumference, fatless body weight, upper arm muscle circumference, hemoglobin, specific volume of red blood cells, absolute value of lymphocytes, albumin, prealbumin, cholesterol and MNA.

3.5 Area under the ROC curve of risk factors for CI in elderly patients with CHF.

The relationship between different nutritional indexes and cognitive impairment in elderly patients with chronic heart failure was analyzed and compared, and the ROC curve was drawn. The results are shown in Table 5. The area under the ROC curve of upper arm circumference, albumin and MNA scores is 0.176, 0.207 and 0.140. Respectively, the AUC values for all three of these indicators were lower. Drawing the combined ROC curve of upper arm circumference, albumin and MNA scores, we found that the AUC value was 0.935, indicating that the combination of upper arm circumference, albumin and MNA scores was closely related to cognitive impairment in elderly patients with chronic heart failure (Table 5, Figure 1).

Table 5
Area under the ROC curve for independent factors of CI in elderly patients with CHF.

Indicators	AUC	95%CI	P
AC	0.176	(0.110 - 0.241)	<0.001
Alb	0.207	(0.142 - 0.273)	<0.001
MNA	0.140	(0.082- 0.198)	<0.001
PRE	0.935	(0.901- 0.970)	<0.001

Discussion

The purpose of this study was to elucidate the relationship between CI and malnutrition in elderly patients with CHF and to determine the relationship between different nutritional indexes and cognitive impairment in patients with chronic heart failure. In this study, the prevalence of CI in patients with CHF was 35.33%, which was relatively low compared with 41.69% found in the study of Farid et al.[22]in hospitalized patients with HF, it is considered to correlate with the higher education level of our included population. Our experimental results in the current study indicate that age and educational attainment are connected to CI, which is consistent with the conclusions reached by other research groups[23]. In the current study we observed that patients with CI were older and less educated than those without CI, which confirms what has been mentioned in some reviews[24]. In addition, we found higher BUN and lower eGFR in patients with CI compared with those without CI. BUN is generally viewed as an indicator to assess renal function, but it has been suggested that BUN may not be a specific renal marker, as some evidence suggests that it increases neurohormonal hormonal activity[25]. The neurohormonal axis has been widely discussed in the mechanisms of CI and HF, and may play a role in the interaction between HF, cognitive function, and structural changes in the brain. The hypothalamic-pituitary-adrenal axis plays an important role in the pathophysiology of CI[26]. Our study showed that eGFR was lower in patients with CI, a result consistent with that mentioned in a review of the relationship between CI and dementia in patients with chronic kidney disease, which concluded that CI is often seen in the early stages of chronic kidney disease[27]. People with chronic kidney disease have poorer cognitive function and a higher risk of CI than those without chronic kidney disease[28, 29]. In terms of heart structure, we observed a higher left atrial diameter in patients with CI, which has been demonstrated to be an independent predictor of cardiovascular events. A cohort study of 2804 people without cardiovascular disease showed that left atrial diameter can independently predict the occurrence of cardiovascular disease[30].

In nutrition, we study the advantage is that we will be related to the nutritional status of laboratory tests, body measurements, the human body composition analysis indexes included in the experiment to comprehensively evaluate the nutritional status of CI in elderly patients with CHF. We found that the arm circumference, albumin and MNA score play a significant role in CI of patients with CHF, independent correlation. In a study on predictors and consequences of changes in physical, emotional, cognitive, and social functioning in older adults in the Netherlands[31], upper arm circumference was a values were identified to better assess of nutritional status in older adults and was more correlated with mortality in older adults, which is consistent with our study. A 2020 study on cognitive function in centenarians showed that calf circumference was more strongly associated with CI risk than common measures of obesity, such as body mass index and waist circumference. In addition, studies have shown that calf circumference in Chinese centenarians is inversely associated with the risk of CI[32]. A Taiwan study showed that arm circumference and calf circumference were better indicators of nutritional status and functional maintenance than BMI among older adults in need of care[33]. It is suggested that upper arm circumference[34] and calf circumference[35] serve as surrogate indicators for assessing malnutrition in the elderly. In our study, upper arm circumference and calf circumference, indicators of nutritional status in the cognitively impaired group, were significant in a univariate analysis. In addition, upper arm circumference was revealed to be an independent risk factor in the multivariate logistic regression analysis. These all suggest that upper arm circumference could be better utilized to appraise the nutritional status of patients. In our study, we found that the group of patients with adverse cardiovascular events was older and had a lower BMI. These patients generally had worse nutritional status and lower HB and cholesterol levels ($P < 0.05$). Also our study showed that albumin levels were an influential factor in malnutrition. These findings, are consistent with the results of a 2019 study on the correlation between patients with acute heart failure with preserved ejection fraction and malnutrition[36]. The MNA is the most established screening and assessment tool for nutritional status in the elderly and for detecting the prognosis of malnutrition in this population[21]. Our study also applied the MNA scale to assess the nutritional status of patients, and the results showed that MNA score in elderly CHF patients is an independent protective factor for CI, which is consistent with the research results of Ai Kimura et al.. [14]. Most important of all, our study also found that MNA score, albumin and arm circumference are closely related to cognitive impairment in elderly patients with CHF. MNA is a practical, non-invasive tool that can quickly assess the nutritional status of frail elderly people[20]. We suggest that early MNA assessment by general practitioners in hospitals and nursing homes for the elderly is highly relevant for early detection of the risk of malnutrition and early management through nutritional interventions. Our study also found that elderly patients with CHF had a higher risk of malnutrition (52.7%). So early identification of malnutrition risk factors in CHF patients could reduce malnutrition and CI in CHF patients.

Controlling Nutritional Status (CONUT) scores[37] are indicators to appraise malnutrition status. CONUT scores are ascertained by three laboratory markers: albumin, total lymphocytes, and total cholesterol. Past studies have shown that albumin is a determinant of malnutrition. In the present experiment, we observed that albumin, lymphocyte absolute value, and total cholesterol in HF patients with CI were significant in a univariate analysis. However, no correlation was found between lymphocyte absolute value and total cholesterol and CI in elderly patients with CHF in multifactorial analysis, but this negative result does not indicate that they are not indicators of malnutrition, and the association between the two indicators and CI in elderly patients with CHF should be confirmed in a larger study of evidence-based medicine.

Study Limitations

The current study has several limitations. First, our study population was all highly educated and therefore did not adequately reflect the generality of the population. Second, since all participants were from the same medical center, the results are limited in terms of generalizability. Third, we used a single screening tool, the MMSE, to assess CI after HF. Although the MMSE is the most commonly used psychometric screening assessment tool to detect cognitive function, other screening tests or multiple cognitive assessment tools are equally valid for psychological assessment, and thus more scales are needed for more detailed analytical assessment. Finally, future research needs to establish a universal screening method for CI in HF patients based on different life, cultural, and educational contexts. It is also warranted to explore new and more precise biological indicators of nutritional aspects affecting CI.

Conclusions

Our study confirmed the significant correlation between malnutrition and CI in elderly patients with CHF. Most importantly, this study simultaneously included laboratory laboratory tests, physical measurements, body composition analysis, and other nutrition-related indicators in the trial and conclusively showed that MNA score, albumin and arm circumference are closely related to cognitive impairment in elderly patients with CHF. Malnutrition as a reversible influencing factor plays an important role in cognitive impairment in elderly CHF patients. Therefore, nutritional assessment should be routinely performed in elderly CHF patients to detect malnutrition early and give appropriate interventions.

Abbreviations

AST: aspartate transaminase; ALT: alanine transaminase; BUN: blood urea nitrogen; Scr:serum creatinine; UA: uric acid; Cys-C: Cystatin C; RBP: retinol binding protein; eGFR: estimated glomerular filtration rate; LAD: left atrial diameter; LVEDD: left ventricular end diastolic diameter; MMSE:Min-Mental State Examinatsion; BMI:Body mass index;WC: waist circumference; AC:arm circumference; CC: calf circumference; FFM: fat free mass; MAMC: mid-arm muscle circumference; VFA:Visceral fat area; Hb: hemoglobin; HCT: hematocrit; LYM#: absolute lymphocyte; Alb: Albumin; LDL-C: Low Density Lipoprotein

Cholesterol; HDL-C: high Density Lipoprotein Cholesterol; MNA:Mini Nutritional Assessment; PRE: prediction probability.

Declarations

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Author contributions

HL designed the study, advised on the analysis, and drafted the manuscript. XPL, WL and JYL advised on the study design, helped to analyze, and interpret the data. KXZ helped to collect the data and revised the manuscript. All authors read and approved the version submitted.

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Availability of data and materials

The data and materials that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

This study was approved by the institutional review committee of the First Hospital of Jilin University (IRB No. 20K093-002). Participants need to fill in an informed consent form, including the purpose of the study and the guarantee of anonymity and confidentiality of their information. This study meets the ethical requirements of Helsinki Declaration.

Consent for publication

Applicable.

Competing interests

The authors declare that there are no financial conflicts of interest in regard to this manuscript.

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Figures

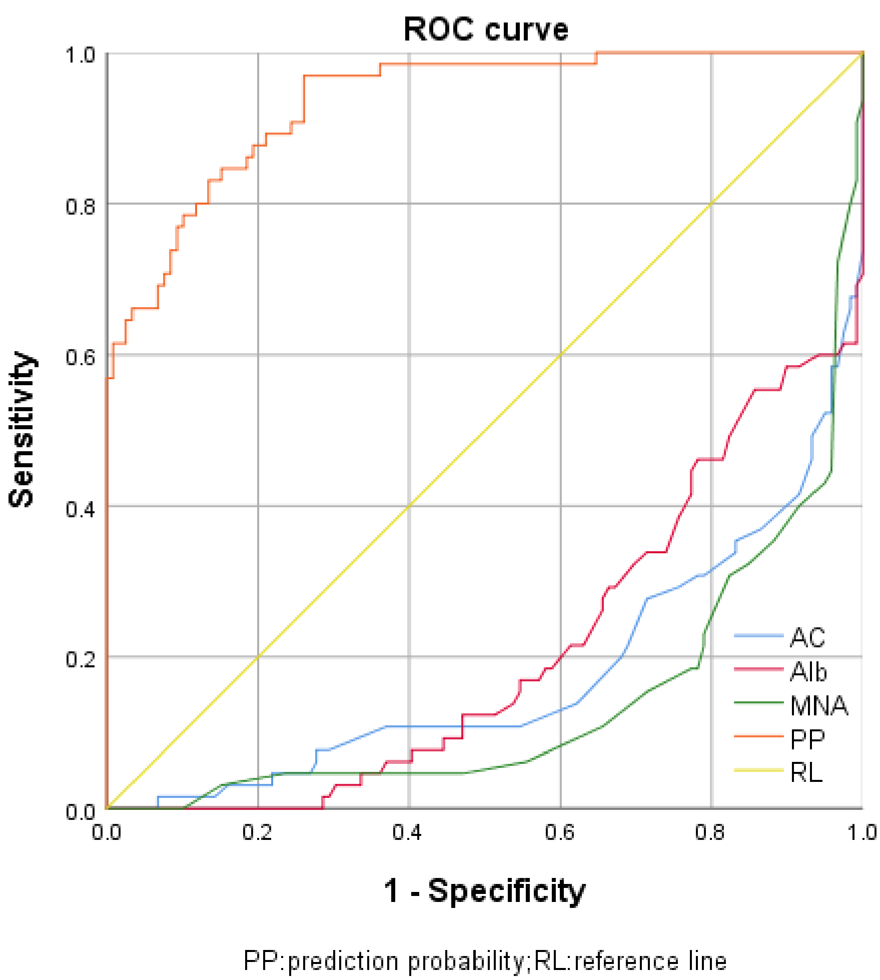

Figure 1

Receiver operating characteristic curves of different nutritional indexes of cognitive impairment in elderly patients with chronic heart failure