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Research Paper

Comparison of the performance of different nutritional indicators for predicting poststroke depression in older adults with ischemic stroke

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A R T I C L E I N F O

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A B S T R A C T

Objective: This study aimed to investigate the relationships between three different nutritional indicators and poststroke depression (PSD) and to analyze the performance of these nutritional indicators in predicting the occurrence of PSD in older adults with ischemic stroke to provide a reference for nurses to identify high-risk patients with PSD early, optimize stroke management, and improve patient prognosis.

Methods: This cohort study prospectively included 239 older adults with ischemic stroke in the Department of Neurology of a hospital in Shenzhen from September 2022 to May 2023. The nutritional status of the patients were evaluated by laboratory indicators, the Mini Nutritional Assessment Short Form (MNA-SF), and the Geriatric Nutrition Risk Index (GNRI). The Hospital Anxiety and Depression Scale-Depression (HADS-D) was used to evaluate PSD. A self-designed questionnaire was used to collect demographic information and disease-related information. Binary logistic regression analysis was performed to analyze factors related to PSD, and receiver operating characteristic curve analysis was also used to compare the performance of these nutritional indicators.

Results: A total of 239 older adults with ischemic stroke were included; the mean age was 71.10 ± 7.41 years, and 66.5% (159/239) were males. The incidence of PSD was 32.6% (78/239). The incidence of PSD in the low-value group was significantly greater than that in the high-value group according to the different nutritional indices, and the difference was statistically significant (all $P < 0.05$). Binary logistic regression analysis revealed that the albumin (ALB) level ($OR = 0.681$; 95% CI, 0.508–0.913; $P = 0.010$), GNRI score ($OR = 1.238$; 95% CI, 1.034–1.483; $P = 0.020$), and MNA-SF score ($OR = 0.708$; 95% CI, 0.614–0.815; $P < 0.001$) were influencing factors for PSD in this population ($P < 0.05$). Combined with the ALB, GNRI, and MNA-SF, the area under the ROC curve for predicting the incidence of PSD in older adults with ischemic stroke was the largest and had a high degree of differentiation (AUC, 0.738; sensitivity, 75.6%; specificity, 60.9%).

Conclusion: The nutritional indices ALB, GNRI, and MNA-SF can be used as auxiliary tools to predict the risk of PSD in older adults with ischemic stroke malnutrition. Further validation by nurses in a more diverse patient population is needed to demonstrate the accuracy of the predictions.

What is known?

- Poststroke depression (PSD) and malnutrition are important complications after stroke. There is a correlation between malnutrition and PSD, but the conclusions are inconsistent across different studies, and further research is still needed.
- Nutritional indicators for predicting the risk of PSD in older adults with ischemic stroke malnutrition have not been fully identified. Early identification of patients at high risk of PSD among malnourished patients helps improve patient prognosis.

What is new?

- Our study revealed that the greatest area under the receiver operating characteristic (ROC) curve was obtained for the nutritional indicators albumin (ALB), the Geriatric Nutrition Risk

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Index (GNRI), and the Mini Nutritional Assessment Short Form (MNA-SF). These indicators are highly variable, have good sensitivity and specificity, and could be used as an auxiliary tool to predict the risk of PSD in malnourished older adults with ischemic stroke.
- Early identification of high-risk patients with PSD can help clinical nurses optimize stroke management and improve patient outcomes.

1. Introduction

Stroke is the second leading cause of death globally [1] and the leading cause of disability [2]. Ischemic stroke accounts for approximately 70% of the incidence of stroke [3]. This disease is characterized by a high morbidity rate, high disability rate, high mortality rate, high recurrence rate, and high economic burden rate, which seriously affects the quality of life of patients and places a heavy burden on individuals, families, and society [4]. According to the 7th National Census report of the National Bureau of Statistics in 2021, there are 264 million people over 60 in China, accounting for 18.7% of the total population, and the aging trend of China's population is an increasing concern [5]. Older adults are the main group affected by stroke [6]. Poststroke depression (PSD) is an important complication after stroke and a common poststroke psychological disorder in older adults with stroke, mainly manifested as apathy and fatigue symptoms, which not only affect functional recovery and lead to a decline in quality of life but are also closely related to high mortality [7]. It is estimated that approximately 1/3 of older adults suffering from ischemic stroke will experience mental and psychological problems, which greatly affect the quality of life and social function of patients [8]. Therefore, exploring the risk factors for PSD is necessary to help identify high-risk patients and intervene early.

Malnutrition is a common complication of stroke patients. Studies have shown that 6.1%–62.0% of stroke patients suffer from malnutrition, and the incidence of malnutrition varies greatly [9]. Moreover, 66.1% of older adults with stroke are malnourished during hospitalization [10]. Yuan et al. showed that malnutrition was common in older Chinese adults with ischemic stroke and was associated with increased mortality [11]. Nutrition management has received increasing attention with the extensive development of stroke units and improvements in stroke management. Malnutrition increases the length of hospital stay and the risk of related complications in patients with ischemic stroke, which is not conducive to the recovery of neurological function [12,13]. Previous study have shown that nutrient metabolism is closely related to PSD and stroke [14]. Malnutrition can be a cause of depression, and improving nutritional status is beneficial to both physical and mental health [15]. On the one hand, nutritional supplements and neuroprotective diets may be associated with better poststroke rehabilitation and neurological function recovery [16]. On the other hand, PSD can reduce the appetite of patients and affect the intake of nutrients, and a lack of nutrients will aggravate PSD, which leads to a negative prognosis, thus forming a vicious cycle [17]. There may be interactions between nutritional status and PSD. However, the relationship between malnutrition and PSD has not been consistent across studies. Some studies have shown that malnutrition (and risk) is an independent risk factor for PSD during the acute phase of stroke [18]. Other study has reported that there is no significant relationship between malnutrition and post-ischemic stroke depression [19]. Currently, there is a lack of clinical evidence on whether baseline malnutrition predicts PSD. The association between malnutrition and PSD in older adults with ischemic stroke is unclear and needs further study.

At present, there is no uniform standard for the diagnosis of malnutrition, and existing studies assess malnutrition in hospitalized patients using several clinical indicators or screening tools, such as Albumin (ALB) [16], the Malnutrition Universal Screening Tool (MUST), the Mini Nutritional Assessment (MNA) [20], and Body Mass Index (BMI) [21], Geriatric Nutritional Risk Index (GNRI) [19] et al. These nutritional indicators or tools have different application scopes and focus, have advantages and disadvantages, and can be selected according to the applicable scope of the study population. ALB can reflect protein storage in the body and is one of the most commonly used clinical nutrition evaluation indicators [22]; it is also associated with depression after stroke in older adults [23]. The Mini Nutritional Assessment Short Form (MNA-SF) is one of the main screening tools recommended by the Global Leadership Initiative on Malnutrition (GLIM) for the nutritional status of older adults [24]. The GNRI is a simple index used to comprehensively and objectively measure the nutritional status of hospitalized older adults [25]. These indicators can represent the nutritional status of older adults with stroke to a certain extent and are subjective and objective indicators that are easy to obtain through assessment, simple to calculate, and representative of nutrition in nurses' clinical work. However, other nutritional status indicators include diet, muscle mass, and the need to use bioelectrical impedance analysis (BIA) methods, CT or MRI, etc. [26], have several drawbacks: they are inconvenient and require specialized equipment that is time-consuming and expensive, which may limit their application in clinical care settings. In addition, few studies have compared the differential performance of different nutritional indicators (ALB, GNRI, and MNA-SF) in predicting PSD in older adults with ischemic stroke.

The purpose of our study was to investigate the relationship between these nutritional indicators and PSD and to analyze the ability of nutritional indicators to predict the occurrence of PSD in older adults with ischemic stroke. We hypothesized that exploring and comparing the performance of these nutritional indicators could help nursing staff use these indicators to identify the risk of malnutrition in patients and take targeted nutritional intervention measures early to prevent the occurrence of PSD, thereby improving the prognosis and rehabilitation of patients and optimizing the management of stroke care. The following questions guided this study: a) What is the relationship between nutritional assessment indicators and PSD in older adults with ischemic stroke? b) How do different nutritional assessment indicators predict PSD performance?

2. Methods

2.1. Study design and participants

This is a cohort study that prospectively collected data on older adults with ischemic stroke who were hospitalized at a Class A tertiary hospital in Shenzhen, Guangdong Province, China, from September 2022 to May 2023. The inclusion criteria for this study were as follows: 1) met the diagnostic criteria for ischemic stroke, confirmed by CT or MRI; 2) were ≥60 years old [5]; 3) patients and their family members provided informed consent and voluntarily participated in and cooperated with this study. The exclusion criteria were as follows: 1) incomplete clinical data or case data; 2) a history of serious medical conditions, including malignant tumors, heart failure, renal insufficiency, cardiogenic cirrhosis, or chronic obstructive pulmonary disease; and 3) a history of depression or other mental illness. A total of 18 dependent variable indicators were included in our study. According to the principle that the sample size is 10–15 times the number of covariates [27], 180–270 cases are planned to be included. With a loss rate of 10%, the sample size was 198–297 patients. This study initially included 243 patients and ultimately included 239 patients after screening.

2.2. Measurements

Data collection was conducted by professionally trained data collectors who completed paper versions of case report forms by consulting the hospital's electronic medical records system and surveying patients face-to-face. Review the general demographic data, nutrition-related assessment indicators investigated in the previous literature [11,28], and the ease of access considerations when collecting data in our hospital. The following data were collected from older adults with ischemic stroke as follows: 1) on the day of admission, age (years), gender, marital status, smoking history, drinking history, educational level, personal monthly income, BMI, dysfunction, the National Institutes of Health Stroke Scale (NIHSS) score, Barthel Index (BI) score, GNRI score, MNA-SF score, total protein (TP), ALB, globulin (GLB), the albumin/globulin ratio (A/G) and hemoglobin (HB) were collected; 2) The HADS-D subscale of the HADS was used to evaluate the depressive symptoms of the patients on the 7th day of hospitalization. The Chinese Stroke Report 2019 showed that patients with ischemic stroke had a hospital stay of between 7 and 13 days [29], while the average hospital stay of the 239 patients surveyed in this study was 8.97 days. Therefore, PSD was assessed on the seventh day.

2.2.1. National Institutes of Health Stroke Scale for neurological impairment

The NIHSS was created by the National Institutes of Health in 1989 to assess the neurological impairment of stroke patients upon admission [30]. The revised version of the NIHSS published in 1994 was used in our study and has been widely used in clinical practice [31], with 11 items and 15 scoring items ranging from 0 to 42 points. The greater the NIHSS score is, the more severe the neurological impairment. 0 was classified as none, 1 to 5 as mild, 6 to 20 as moderate, and 21 to 42 as severe.

2.2.2. Barthel index for Activities of Daily Living

The BI for Activities of Daily Living (ADL), developed by Mahoney and Barthel in 1965, is the most widely used method for evaluating daily living activities. The scale includes 10 items, such as eating, bathing, dressing, going up and down stairs, bowel movements, urinating, toilet use, flat walking, bed chair movement, bathing, and grooming, with a total possible score of 100. The higher the score is, the better the daily living ability [32]. The Cronbach's α coefficient of the Chinese version of the BI is 0.92, indicating that the BI has high internal consistency [33].

2.2.3. Nutritional assessment tool

The GNRI, developed by Bouillanne et al., in 2005, is a malnutrition risk scoring tool for older patients. The scoring formula was $1.489 \times$ ALB (g/L)+ $41.7 \times$ actual body weight (kg)/ideal body weight. Ideal weight was calculated using the Lorentz formula: men's height (cm) - 100 - ([height (cm) - 150]/4), women's height (cm) - 100 - ([height (cm) - 150]/2.5). When the actual weight exceeds the ideal weight, the actual weight/ideal weight ratio is 1. The lower the score is, the greater the risk of malnutrition. According to the GNRI, the patients were divided into two nutritional risk groups: no malnutrition (GNRI $\geq$100) and malnutrition (GNRI <100) [34].

We used a revised version of the MNA-SF developed by Kaiser et al., in 2009 [35], based on the version developed by Guigoz et al., in 1996 [36] and Rubenstein et al., in 2001 [37]. The MNA-SF evaluates the nutritional status of older adults based on six items: swallowing and digestion, disease stress, bed rest, mental health, and BMI (which can be replaced by calf circumference). The scoring criteria were as follows: a total score of 14 points, 12 to 14 points indicating good nutritional status, 8 to 11 points indicating underlying malnutrition, and 0 to 7 points indicating malnutrition. The Cronbach's α coefficient for the MNA-SF in this study was 0.812, demonstrating high reliability.

2.2.4. Hospital Anxiety and Depression Scale-depression for PSD

The HADS was developed by Zigmond et al., in 1983 [38]. It is mainly used for screening for anxiety and depression in inpatients in general hospitals. There are 14 items in the HADS, seven of which assess depression and seven of which assess anxiety. Scores of 0–7 indicate no symptoms; scores of 8–10 indicate suspicious symptoms; scores of 11–21 indicate significant symptoms. Existing studies have used the HADS to evaluate hospitalized stroke patients, and the results are good [39]. In our study, we used the HADS-D subscale of the Chinese version of the HADS to assess depressive symptoms among patients, and these authors reported that a cutoff value of 9 had the greatest effect on depression [40]. Therefore, we divided the patients into two groups: 0 to 8 without PSD and 9 to 21 with PSD. The Cronbach's α coefficient of the HADS-D in this study was 0.820, indicating high reliability.

2.3. Data collection

Potential participants were identified by ward nurses using established inclusion and exclusion criteria. A nursing graduate student (S. Hu) and a supervisor (registered nurse, RN) conducted the survey after two training days. Those who agreed to participate confirmed a signed written informed consent form. The questionnaire data were collected through one-on-one, face-to-face surveys and asked individually. During the survey, nursing graduate students (S. Hu and M. Gao) were primarily responsible for data collection, while RN supervised the work to ensure coordination and standardization of the survey process. Each survey was conducted at the patient's bedside and took approximately 15–20 min to complete. During this process, participants rested freely to reduce possible physical discomfort. In the case of unclear responses to the questionnaire, participants were asked to clarify or, if necessary, seek the help of a caregiver to clarify the participants' responses. A total of 243 participants completed the face-to-face questionnaire, four (1.7%) of whom were excluded for missing five or more answers; four older adults had missing laboratory data (TP, ALB, GLB, A/G, and HB), and one lacked both laboratory data (TP, ALB, GLB, A/G, and HB) and body weight data. Overall, 239 questionnaires were available for the final analysis, with a response rate of 98.3%.

2.4. Statistical analysis

SPSS version 25.0 (SPSS Inc., Chicago, IL, USA) was used for the data analysis. Normally distributed quantitative data were expressed as the mean, standard deviation, and an independent sample *t*-test was used. Qualitative data were represented by the number of cases, and percentages (%) and Chi-square test were calculated. Binary logistic regression analysis was used, and the area under the receiver operating characteristic (ROC) curve was used to evaluate the predictive value of nutritional indicators (ALB, GNRI, and MNA-SF) in older adults with ischemic stroke. $P < 0.05$ was considered to indicate statistical significance.

2.5. Ethical considerations

The study protocol was approved by the Ethics Committee of the Second People's Hospital of Shenzhen (No. 20220708001). Only when accompanied by qualified internal staff did the investigators have access to the participants' medical records and contact with the participants. Coded sequential numbers replaced the names of the participants, and only the investigators had access to the list. All participants provided oral or written consent.

3. Results

3.1. Characteristics of the participants

The average age of the participants was (71.10 ± 7.41) years, ranging from 60 to 96 years. Most participants were male (66.53%, 159/239). There were differences in ADL, ALB level, A/G ratio, GNRI, and MNA-SF score between the two groups ($P < 0.05$) (Table 1).

3.2. Comparison of the incidence of PSD in the different nutritional indicators groups

PSD occurred in 78 of 239 patients (32.6%). In the ALB, A/G, GNRI, and MNA-SF groups, the incidence of PSD in the low-value group was 51.9% (14/27), 56.7% (17/30), 40.4% (55/136) and 62.2% (23/37), respectively. The incidence of PSD in the high-value group was 30.2% (64/212), 29.2% (61/209), 22.3% (23/103) and 16.0% (14/88), and there was a significant difference in the incidence of PSD among the four groups ($\chi^2 = 5.11$, $P < 0.05$; $\chi^2 = 9.00$, $P < 0.05$; $\chi^2 = 8.75$, $P < 0.05$; $\chi^2 = 26.45$, $P < 0.001$) (Table 2).

3.3. Binary logistic regression analysis of PSD

Independent variables with differences in the univariate analysis were included in the multivariate binary logistic regression model, and the analysis results showed that the ALB level, GNRI, and MNA-SF score were independent risk factors for PSD ($P < 0.05$) (Table 3).

3.4. The clinical value of nutritional status in predicting PSD in older adults with ischemic stroke

Patients with PSD were positive, and those without PSD were negative. ALB, the GNRI, and the MNA-SF were used to predict PSD. ROC curve analysis revealed that the areas under the ROC curves for the ability of the ALB level, GNRI, and MNA-SF score to predict PSD in older adults with ischemic stroke were 0.371, 0.394, and 0.294, respectively. These findings suggest that the ALB level, GNRI, and MNA-SF scores are not able to predict PSD. Combined with the ALB level, GNRI, and MNA-SF score, the area under the ROC curve for predicting PSD in older adults with ischemic stroke reached 0.738, the sensitivity was 75.6%, the specificity was 60.9%, the Joden index was 0.365, and the best decision value was approximately 0.279. It has been suggested that the combined prediction of PSD in older

Table 1
Comparison of study population characteristics and clinical data between the two groups.

Variables	Without PSD ($n = 161$)	PSD ($n = 78$)	t/χ^2	P
Age (years)	70.63 ± 7.57	72.06 ± 7.02	−1.40	0.162
Gender				
Female	55 (68.8)	25 (31.2)	0.11	0.746
Male	106 (66.7)	53 (33.3)		
Marital status				
Married	144 (67.3)	70 (32.7)	0.01	0.005
Unmarried\divorced\widowed	17 (68.0)	8 (32.0)		
Degree of education				
Primary and below	47 (61.8)	29 (38.2)	3.09	0.213
Junior high\secondary\high school	77 (73.3)	28 (26.7)		
Junior college\undergraduate or above	37 (63.8)	21 (36.2)		
Personal monthly income (RMB)				
<5,000	84 (65.1)	45 (34.9)	0.64	0.422
≥5,000	77 (70.0)	33 (30.0)		
Smoking				
No	88 (69.9)	38 (30.1)	0.74	0.388
Yes	73 (64.6)	40 (35.4)		
Drinking				
No	92 (69.7)	40 (30.3)	0.73	0.393
Yes	69 (64.5)	38 (35.5)		
Dysfunction				
No	22 (81.5)	5 (18.5)	2.76	0.097
Yes	139 (65.6)	73 (34.4)		
ADL	86.48 ± 19.22	77.31 ± 26.63	2.72	0.008
NIHSS				
0	67 (72.0)	26 (28.0)	2.24	0.326
1–5	84 (65.6)	44 (34.4)		
6–20	10 (55.6)	8 (44.4)		
Nutritional assessment indicators				
BMI (kg/m^2)	24.18 ± 2.92	23.80 ± 2.92	0.93	0.354
TP (g/L)	65.69 ± 4.84	64.42 ± 6.39	1.55	0.123
ALB (g/L)	39.29 ± 3.91	37.68 ± 4.44	2.87	0.005
GLB (g/L)	26.34 ± 4.34	26.76 ± 5.43	−0.59	0.556
A/G (Ratio)	1.54 ± 0.26	1.46 ± 0.31	2.09	0.039
HB (g/L)	129.98 ± 15.10	130.94 ± 17.10	−0.44	0.659
GNRI	99.35 ± 6.14	96.82 ± 7.57	2.76	0.006
MNA−SF	10.89 ± 2.39	9.05 ± 2.52	5.48	<0.001

Note: Data are *Mean* ± *SD* or *n*(%). ADL = Activity of Daily Living. NIHSS = National Institutes of Health Stroke Scale. BMI = body mass index. TP = total protein. ALB = albumin. GLB = globulin. A/G = albumin/globulin ratio. HB = hemoglobin. GNRI = Geriatric Nutritional Risk Index. MNA-SF = Mini Nutritional Assessment Short Form. PSD = poststroke depression.

Table 2
Comparison of the incidence of PSD in the ALB, A/G, GNRI and MNA-SF groups ($n = 239$).

Variables	*n*	ALB		A/G		GNRI		MNA- SF		
		<40	40–55	<1.2	1.2–2.4	<100	≥100	≤7	8–11	12–14
Without PSD	161	13 (48.1)	148 (69.8)	13 (43.3)	148 (70.8)	81 (59.6)	80 (77.7)	14(37.8)	73 (64.0)	74 (84.0)
PSD	78	14 (51.9)	64 (30.2)	17 (56.7)	61 (29.2)	55 (40.4)	23 (22.3)	23 (62.2)	41 (36.0)	14 (16.0)
χ^2		5.11		9.00		8.75		26.45		
P		0.024		0.003		0.003		<0.001		

Note: Data are *n*(%). ALB = albumin. A/G = albumin/globulin ratio. GNRI = Geriatric Nutritional Risk Index. MNA-SF = Mini Nutritional Assessment Short Form. PSD = poststroke depression.

Table 3
Binary logistic regression analysis of PSD ($n = 239$).

Variables	β	Wald χ^2	*OR*	95% CI	*P*
ADL	−0.005	0.450	0.995	0.981–1.009	0.502
ALB	−0.384	6.607	0.681	0.508–0.913	0.010
A/G	−0.470	0.554	0.625	0.181–2.155	0.457
GNRI	0.214	5.396	1.238	1.034–1.483	0.020
MNA- SF	−0.346	23.005	0.708	0.614–0.815	<0.001

Note: ADL = Activity of Daily Living. ALB = albumin. A/G = albumin/globulin ratio. GNRI = Geriatric Nutritional Risk Index. MNA-SF = Mini Nutritional Assessment Short Form. PSD = poststroke depression.

adults with ischemic stroke has a high degree of differentiation (Table 4 and Fig. 1).

4. Discussion

Our study revealed that the incidence of PSD in older adults with ischemic stroke was 32.6%, which was similar to the findings of clinical reports [19]. At present, there are endogenous and exogenous hypotheses about the pathogenesis of PSD [41], and Klimova et al. systematically reviewed the effects of nutrition and the gut microbiota on depression in older adults and showed that nutrient intake, the gut microbiota, and the central nervous system are associated with depression; the gut can receive regulatory signals from the central nervous system, and transmit signals to the central nervous system that are received by the brain; this two-way regulatory channel is called the "gut-brain axis" [42]. When the physiological state is stable, the gut-brain axis system is in a dynamic balance. If the microorganisms in the gut overgrow and the body suffers from insufficient nutrition, the balance may be disrupted, resulting in gastrointestinal disorders, malnutrition, etc., which may lead to a seemingly unrelated central nervous system disease, such as depression [14]. PSD, as a kind of emotional disorder, not only affects the recovery of neurological function but also causes social function deficits, which can increase the risk of suicide and death in patients to a certain extent [43]. Therefore, early prevention and early treatment of PSD can promote the recovery of neurological function and improve the quality of life of older adults with ischemic stroke.

The results of Table 2 of our study showed that the incidence of PSD in the low-value group was greater than that in the high-value group according to the different nutritional indices, and the difference was statistically significant (all $P < 0.05$), indicating that older adults with ischemic stroke and a greater nutritional risk level had a greater incidence of PSD at seven days of hospitalization. However, the relationship between malnutrition and PSD has not been consistent across studies. A study of 307 ischemic stroke patients (mean age 63 years) showed that low serum prealbumin levels at admission were associated with PSD one month after stroke onset [44]. Malnutrition (and risk) is an independent risk factor for PSD in the acute stage of stroke, and its risk is 3.990 times that of normal people with nutritional status [18]. A recent Chinese study revealed that there was no significant relationship between the GNRI score and PSD in older adults [19]. Currently, few studies have reported that depression occurs as a result of malnutrition. Depression is often considered a risk factor for malnutrition in stroke patients [16,45]. It could be that stroke survivors with depression have less activity and energy intake. Some studies have also confirmed a strong correlation between nutritional status and

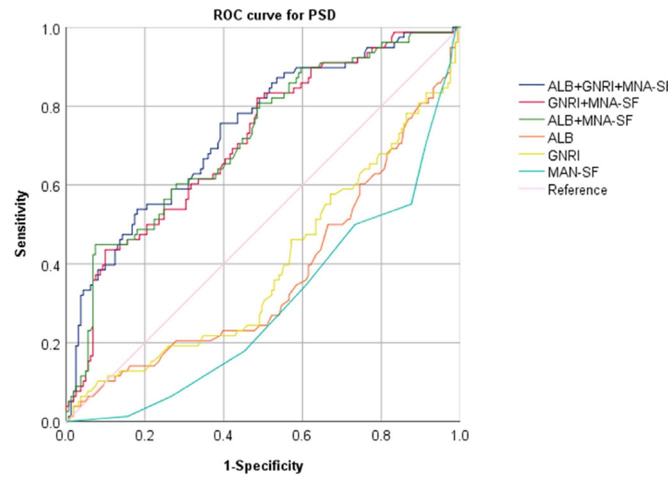

Fig. 1. ROC curve of nutritional status for predicting PSD in older adults with ischemic stroke. ALB = albumin. GNRI = Geriatric Nutritional Risk Index. MNA-SF = Mini Nutritional Assessment Short Form. ROC = receiver operating characteristic. PSD = poststroke depression.

Table 4
The clinical value of nutritional status in predicting PSD in older adults with ischemic stroke ($n = 239$).

Variables	Statistical value		Sensitivity, %	Specificity, %	Youden index	Cutoff
	AUC (95% CI)	*P*				
ALB	0.371 (0.294–0.449)	0.001	0.038	0.981	0.019	44.900
GNRI	0.394 (0.316–0.472)	0.008	0.064	0.963	0.027	106.843
MNA-SF	0.294 (0.226–0.363)	<0.001	1.000	0.006	0.006	2.500
ALB + GNRI + MNA-SF	0.738 (0.671–0.806)	<0.001	0.756	0.609	0.365	0.279
GNRI + MNA-SF	0.712 (0.643–0.781)	<0.001	0.821	0.516	0.337	0.256
ALB + MNA-SF	0.718 (0.649–0.787)	<0.001	0.449	0.925	0.374	0.466

Note: ALB = albumin. GNRI = Geriatric Nutritional Risk Index. MNA-SF = Mini Nutritional Assessment Short Form. AUC = area under the curve. PSD = poststroke depression.

depression [46,47]. We believe that regardless of whether malnutrition in older adults with stroke is significantly associated with PSD, we should pay more attention to patients' nutritional and psychological status.

Based on the previous studies, this study collected nutritional assessment indicators, such as laboratory indicators, subjective and objective nutritional assessment tools, and explored the relationships between the ALB level, GNRI, and MNA-SF score and PSD in older adults with ischemic stroke. The results showed that the ALB level, GNRI, and MNA-SF score at admission were found to be independent influencing factors for PSD in older adults with ischemic stroke after seven days of hospitalization. The ALB level, GNRI, and MNA-SF score alone have a low predictive effect on PSD in older adults with ischemic stroke, but the combination of the ALB level, GNRI, and MNA-SF score has a better predictive effect on PSD. The combination of these three indicators can be used as a potential predictor of PSD in older adults with ischemic stroke. These findings can be used as a valuable reference for the early identification of high-risk patients who may develop PSD after malnutrition in older adults with ischemic stroke for clinical practice, thus providing an important reference for optimizing stroke management, reducing complications, and improving prognosis. Few studies have been conducted to predict PSD in older adults with ischemic stroke using a combination of nutritional indicators or tools.

In our study, there may be many reasons for the low predictive validity of ALB, GNRI, and MNA-SF. Just older adults with ischemic stroke who were hospitalized were enrolled, and the average length of hospitalization was approximately 8.97 days. Only the ALB level, GNRI, and MNA-SF score on the day of admission were collected. The ALB level reflects nutritional status and is affected by factors such as inflammation or disease stress. Therefore, the predictive effect of using ALB alone may be limited, and our ROC analysis results confirmed that the AUC of ALB is less sensitive. Other nutritional assessment tools (NSTs) are recommended for stroke patients unless accompanied by an assessment of edema and inflammatory status and to rule out conditions causing hypoalbuminemia [48]. The GNRI is a simple index used to comprehensively and objectively measure nutrition based on blood biochemistry and BMI in patients with malignant tumors and cardiovascular diseases [25]. Originally used to estimate the risk of malnutrition-related complications in aging populations, the GNRI is the tool of choice for screening the nutritional status of hospitalized older adults. However, the AUC of the GNRI alone in our study was only slightly greater than that of the ALB level and the MNA-SF score, which were far less than 0.7, although the difference was statistically significant ($P < 0.05$). The GNRI can be regarded as a complementary indicator to improve diagnostic accuracy and reduce joint nutritional prediction and evaluation limitations. Similarly, in our study, the predictive ability of the MNA-SF was also poor, with an AUC of 0.294, although the difference was statistically significant ($P < 0.05$). A lower cutoff point for the MNA-SF may be more appropriate for stroke patients because some of the tool's cutoff point categories, such as mobility or neuropsychological problems, may be reduced by the after effects of stroke itself, such as hemiplegia or aphasia [49]. However, in the multivariate analysis of this study, there was no significant difference in the incidence of PSD between patients with low ADL scores and poststroke sequelae and patients with high ADL scores and no poststroke sequelae ($P > 0.05$). The possible reason is that the disease severity of the subjects included in this study was relatively mild, and only 7.5% had NIHSS scores greater than five. Other studies have shown that the MNA-SF and GNRI have comparable simultaneous validity in stroke patients [48]. Previous studies have shown that BMI is an independent predictor of poststroke malnutrition [21]. However, in our study, BMI and the occurrence of PSD in older adults with ischemic stroke were not significantly different, and we did not explore the relationship between BMI and malnutrition in patients, which is a shortcoming of the present study. However, few studies have further explored the relationship between BMI and the incidence of PSD, which we believe is necessary.

To determine the total predictive value of the combination of the ALB level, GNRI, and MNA-SF score, the variables of the ALB level, GNRI, and MNA-SF score were simultaneously included in bivariate logistic regression fitting, and logit (*P*) was returned as the predictive probability and as an independent predictor for ROC analysis. We found that the AUC of the combination of the ALB level, GNRI, and MNA-SF score was the largest among all variables, with statistically significant differences ($P < 0.05$). In addition, the combined use of the ALB level, GNRI, and MNA-SF score can improve the sensitivity and specificity compared with the use of a single indicator, suggesting that in clinical practice, the combination of the ALB level, GNRI, and MNA-SF score can achieve a greater ability to predict the incidence of PSD in older adults with ischemic stroke. However, few studies have been conducted to predict PSD in older adults with ischemic stroke using a combined nutritional assessment tool.

Kris-Etherton et al. showed that adopting a healthy diet pattern that meets nutritional requirements to ensure adequate physical nutrition plays an important role in preventing, slowing, or managing the progression of depressive symptoms and promoting mental health [50]. According to the National Health and Nutrition Examination Survey (NHANES) from 2005 to 2014, increasing the intake of dietary antioxidants (such as vitamin A, vitamin C, vitamin E, zinc, selenium, and carotenoids), as well as the complex dietary antioxidant index (CDAI), can prevent depressive symptoms and improve outcomes in stroke patients [51]. The Mediterranean diet, with olives as the main dietary component, has been reported to avoid and improve neurological abnormalities. Regular intake of olivoroside appears to be associated with a reduced risk of neurological diseases, including Alzheimer's disease, Parkinson's disease, stroke, depression, anxiety, and epilepsy [52]. Malnutrition and PSD in stroke patients often lead to more serious adverse outcomes, increasing the burden on patients' families and nurses [53]. Nursing practice guidelines for enteral nutrition in patients with stroke in China recommend multidisciplinary nutrition management, and team members should include neurologists, nurses, dietitians, rehabilitation therapists, and psychological counselors to form an efficient cooperation model [54]. Nurses who spend more time in contact with patients in clinical work should play an important role in improving the nutritional status of stroke patients. Through the establishment of a complete nutritional nursing management system, norms, and processes; the implementation of training and testing for nutrition management team members; the implementation of nutritional risk screening and assessment; the implementation of correct, effective, and individualized nutritional care; and the evaluation of the effect of nutritional nursing, the quality of nutritional care should be continuously improved to improve the nutritional status of patients and promote their rehabilitation.

Our research findings can help clinical nurses use these nutritional indicators to identify the risk of malnutrition in older adults with ischemic stroke at an early stage and take targeted nutritional intervention measures together with multidisciplinary nutrition management teams to prevent the occurrence of PSD to improve the prognosis and rehabilitation of patients and optimize stroke nursing management.

5. Limitations

This study has several limitations. First, the small sample size of our study may affect the statistical efficiency. In the future, we need to expand the research scope and increase the sample size to verify our results. Second, due to the limited length of hospital stay, we collected outcome indicators on the seventh day of hospitalization and did not assess long-term PSD, which may lead to bias in the analysis and affect the generalizability of the study results. The next step in our study will be long-term follow-up of patients for nutrition and depression status. Due to the heterogeneity of the study population, we only collected the values of albumin, GNRI, and MNA-SF once, and the direction of a causal relationship between them and post-stroke depression may be uncertain. In the future studies, the nutritional status of patients should be dynamically evaluated, and confounding variables should be adjusted in statistical analysis to improve the study's persuasive conclusion. Despite these limitations, we believe that the data are valid in presenting associations between in-hospital malnutrition and PSD in older adults with ischemic stroke assessed jointly by the ALB, GNRI, and MNA-SF.

6. Conclusions

In summary, our study revealed an independent relationship between a lower ALB level, GNRI, and MNA-SF score at admission and PSD in older adults with ischemic stroke after seven days of hospitalization, suggesting that a higher nutritional risk grade at baseline may imply a greater risk of PSD. ALB, the GNRI, and the MNA-SF alone were not better at distinguishing the occurrence of PSD. When the ALB level, GNRI, and MNA-SF scores are combined, their predictive power for PSD may be stronger. Further validation by nurses in a more diverse patient population is needed to demonstrate the accuracy of the predictions.

CRediT authorship contribution statement

Shoudi Hu: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing - original draft, Writing - review & editing, Project administration. **Maofeng Gao**: Conceptualization, Methodology, Validation, Writing - review & editing, Project administration. **Yu He**: Formal analysis, Investigation, Date curation, Writing - review & editing. **Xiaohua Xie**: Funding acquisition, Resources, Writing - review & editing, Supervision, Project administration.

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Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declaration of competing interest

The authors declared there is no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2024.06.006.

References

[1] GBD 2016 Neurology Collaborators. Global, regional, and national burden of neurological disorders, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol 2019;18(5):459–80. https://doi.org/10.1016/S1474-4422(18)30499-X.
[2] Tsao CW, Aday AW, Almarzooq ZI, Anderson CAM, Arora P, Avery CL, et al. Heart disease and stroke statistics-2023 update: a report from the American heart association. Circulation 2023;147(8):e93–621. https://doi.org/10.1161/CIR.0000000000001123.
[3] Wang W, Jiang B, Sun H, Ru X, Sun D, Wang L, et al. Prevalence, incidence, and mortality of stroke in China: results from a nationwide population-based survey of 480 687 adults. Circulation 2017;135(8):759–71. https://doi.org/10.1161/CIRCULATIONAHA.116.025250.
[4] Wang LD, Peng B, Zhang HQ, Wang YL, Liu M, Shan CL, et al. Brief report on stroke prevention and treatment in China, 2020. Chin J Cerebrovasc Dis 2022;19(2):136–44. https://doi.org/10.3969/jl.issn.1672-5921.2022.02.011 [in Chinese].
[5] The People's Republic of China. Protection of the rights and interests of the elderly. http://www.npc.gov.cn/wxzl/gongbao/1996-08/29/content_1479994.htm [Accessed 12 March 2020].
[6] Yuan XX, Yuan SC, Gao ZS, Xu J. 2017-2019 years analysis of disease burden of stroke in Guangzhou. Chin J Prev Contr Chron Dis 2021;29(6):474–8. https://doi.org/10.16386/j.cjpccd.issn.1004-6194.2021.06.017 [in Chinese].
[7] Kasahara J, Uchida H, Tezuka K, Oka N. Postischemic anhedonia associated with neurodegenerative changes in the hippocampal dentate gyrus of rats. Neural Plast 2016;2016:5054275. https://doi.org/10.1155/2016/5054275.
[8] Hackett ML, Pickles K. Part I:frequency of depression after stroke: an updated systematic review and meta-analysis of observational studies. Int J Stroke 2014;9(8):1017–25. https://doi.org/10.1111/ijs.12357.
[9] Sabbouh T, Torbey MT. Malnutrition in stroke patients:risk factors, assessment, and management. Neurocritical Care 2018;29(3):374–84. https://doi.org/10.1007/s12028-017-0436-1.
[10] Çoban E. Malnutrition rate in stroke patients on admission. Sisli Etfal Hastan Tip Bul 2019;53(3):272–5. https://doi.org/10.14744/SEMB.2018.81994.
[11] Yuan K, Zhu S, Wang H, Chen J, Zhang X, Xu P, et al. Association between malnutrition and long-term mortality in older adults with ischemic stroke. Clin Nutr 2021;40(5):2535–42. https://doi.org/10.1016/j.clnu.2021.04.018 [in Chinese].
[12] Yang GX, Sun Y. Effect of early nutritional management on prognosis of elderly patients with acute stroke. Practical Journal of Clinical Medicine 2019;16(3):153–6. http://www.cqvip.com/QK/97365A/201903/7001984247.html [in Chinese].
[13] Zhou F, Fan TL, Chen XH, Zhou ZD, Wang XJ. Relationship between nutritional status and post-stroke cognitive dysfunction in elderly patients with ischemic stroke. J Clin Pathology Res 2022;42(3):668–73. https://doi.org/10.3978/j.issn.2095-6959.2020.03022 [in Chinese].
[14] Wei X, Dongfang L. Research progress of the relationship between post-stroke depression and nutrition metabolism and the underlying mechanism. Chin J Cerebrovasc Dis (Electronic Edition) 2020;14(4):230–3. https://doi.org/10.11817/j.issn.1673-9248.2020.04.009 [in Chinese].
[15] Islam MZ, Disu TR, Farjana S, Rahman MM. Malnutrition and other risk factors of geriatric depression: a community-based comparative cross-sectional study in older adults in rural Bangladesh. BMC Geriatr 2021;21(1):572. https://doi.org/10.1186/s12877-021-02535-w.
[16] Zielińska-Nowak E, Cichon N, Saluk-Bijak J, Bijak M, Miller E. Nutritional supplements and neuroprotective diets and their potential clinical significance in post-stroke rehabilitation. Nutrients 2021;13(8):2704. https://doi.org/10.3390/nu13082704.
[17] Chen N, Li Y, Fang J, Lu Q, He L. Risk factors for malnutrition in stroke patients: a meta-analysis. Clin Nutr 2019;38(1):127–35. https://doi.org/10.1016/j.clnu.2017.12.014 [in Chinese].
[18] Cao KY, LiuSH Zhang C, Gong XQ, Zhong P. Correlation between comprehensive geriatric assessment and post-stroke depression. Journal of Medical Information 2023;36(4):94–100. https://doi.org/10.3969/j.issn.1006-

1959.2023.04.018 [in Chinese].
[19] Hua J, Lu J, Tang X, Fang Q. Association between geriatric nutritional risk index and depression after ischemic stroke. Nutrients 2022;14(13):2698. https://doi.org/10.3390/nu14132698.
[20] Kondrup J, Allison SP, Elia M, Vellas B, Plauth M, et al. ESPEN guidelines for nutrition screening 2002. Clin Nutr 2003;22(4):415–21. https://doi.org/10.1016/s0261-5614(03)00098-0.
[21] Wong HJ, Harith S, Lua PL, Ibrahim KA. Prevalence and predictors of malnutrition risk among post-stroke patients in outpatient setting: a cross-sectional study. Malays J Med Sci 2020;27(4):72–84. https://doi.org/10.21315/mjms2020.27.4.7.
[22] Xu CL, Shen QY, Huang LY, Zhang WH, Tong Y, Lu HY. Research progress on nutritional assessment methods for patients with chronic kidney disease. Chin Nurs Res 2018;32(9):1354–6. https://doi.org/10.12102/j.issn.1009-6493.2018.09.008 [in Chinese].
[23] Pascoe MC, Skoog I, Blomstrand C, Linden T. Albumin and depression in elderly stroke survivors: an observational cohort study. Psychiatry Res 2015;230(2):658–63. https://doi.org/10.1016/j.psychres.2015.10.023.
[24] Cederholm T, Jensen GL, Correia MITD, Gonzalez MC, Fukushima R, Higashiguchi T, et al. GLIM criteria for the diagnosis of malnutrition - a consensus report from the global clinical nutrition community. Clin Nutr 2019;38(1):1–9. https://doi.org/10.1016/j.clnu.2018.08.002.
[25] Kang MK, Kim TJ, Kim Y, Nam KW, Jeong HY, Kim SK, et al. Geriatric nutritional risk index predicts poor outcomes in patients with acute ischemic stroke - automated undernutrition screen tool. PLoS One 2020;15(2):e0228738. https://doi.org/10.1371/journal.pone.0228738.
[26] Beberashvili I, Azar A, Sinuani I, Shapiro G, Feldman L, Stav K, et al. Bioimpedance phase angle predicts muscle function, quality of life and clinical outcome in maintenance hemodialysis patients. Eur J Clin Nutr 2014;68(6):683–9. https://doi.org/10.1038/ejcn.2014.67.
[27] Fang JQ. Health Statistics. Beijing: People's Medical Publishing House; 2012. p. 399–400. https://xueshu.baidu.com/usercenter/paper/show?paperid=479a33f9fc2eaba37fc48f3941eb2595&site=xueshu_se [in Chinese].
[28] Sabbouh T, Torbey MT. Malnutrition in stroke patients: risk factors, assessment, and management. Neurocritical Care 2018;29(3):374–84. https://doi.org/10.1007/s12028-017-0436-1.
[29] Wang YJ, Li ZX, Gu HQ, Zhai Y, Jiang Y, Zhao XQ, et al. The Chinese stroke report 2019(Chinese version)(3). Chin J Stroke 2020;15(12):1251–63. https://doi.org/10.3969/j.issn.1673-5765.2020.12.001 [in Chinese].
[30] Brott T, Adams Jr HP, Olinger CP, Marler JR, Barsan WG, Biller J, et al. Measurements of acute cerebral infarction: a clinical examination scale. Stroke 1989;20(7):864–70. https://doi.org/10.1161/01.str.20.7.864.
[31] Lyden P, Brott T, Tilley B, Welch KM, Mascha EJ, Levine S, et al. Improved reliability of the NIH stroke scale using video training. NINDS TPA stroke study group. Stroke 1994;25(11):2220–6. https://doi.org/10.1161/01.str.25.11.2220.
[32] Mahoney FI, Barthel DW. Functional evaluation:the Barthel index. Md State Med J 1965;14:61–5. https://pubmed.ncbi.nlm.nih.gov/14258950/.
[33] Chen S, Cui Y, Zheng J, Xing Y, Sun CX. The difference in unmet needs of Activities in Daily Living between disabled elderly people living in nursing homes and families Chinese. J Nurs 2019;54(3):434e8. https://doi.org/10.3761/j.issn.0254-1769.2019.03.021 [in Chinese].
[34] Bouillanne O, Morineau G, Dupont C, Coulombel I, Vincent JP, Nicolis I, et al. Geriatric Nutritional Risk Index: a new index for evaluating at-risk elderly medical patients. Am J Clin Nutr 2005;82(4):777–83. https://doi.org/10.1093/ajcn/82.4.777.
[35] Kaiser MJ, Bauer JM, Ramsch C, Uter W, Guigoz Y, Cederholm T, et al. Validation of the Mini Nutritional Assessment short-form (MNA-SF): a practical tool for identification of nutritional status. J Nutr Health Aging 2009;13(9):782–8. https://doi.org/10.1007/s12603-009-0214-7.
[36] Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. Nutr Rev 1996;54(1 Pt 2):S59–65. https://doi.org/10.1111/j.1753-4887.1996.tb03793.x.
[37] Rubenstein LZ, Harker JO, Salvà A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci 2001;56(6):M366–72. https://doi.org/10.1093/gerona/56.6.m366.
[38] Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67(6):361–70. https://doi.org/10.1111/j.1600-0447.1983.tb09716.x.
[39] Dong X, Yang S, Guo Y, Lv P, Liu Y. Exploring psychoneurological symptom clusters in acute stroke patients: a latent Class analysis. J Pain Res 2022;15:789–99. https://doi.org/10.2147/JPR.S350727.
[40] Ye WF, Xu JM. "General hospital anxiety and depression scale" application and evaluation in general hospital patients. Chinese Journal of Behavioral Medicine 1993;(3):17–9. http://www.cqvip.com/qk/98293x/199303/1250387.html [in Chinese].
[41] Qian SX, Yue WQ, Zhang XL, Guan QB. Prevalence and related factors of post-stroke depression. Chinese Journal of General Practice 2016;14(6):950–952+78. https://doi.org/10.16766/j.cnki.issn.1674-4152.2016.06.021 [in Chinese].
[42] Klimova B, Novotny M, Valis M. The impact of nutrition and intestinal microbiome on elderly depression-A systematic review. Nutrients 2020;12(3):710. https://doi.org/10.3390/nu12030710.
[43] Ribeiro NF, Madruga L. A sudden and severe depressive episode after a left cingulate gyrus stroke: a case report of post-stroke depression and review of literature. J Neural Transm 2021;128(5):711–6. https://doi.org/10.1007/s00702-021-02334-y.
[44] Wang L, Xu H, Ren W, Zhu L, Chang Y, Gu Y, et al. Low serum prealbumin levels in post-stroke depression. Psychiatry Res 2016;246:149–53. https://doi.org/10.1016/j.psychres.2016.09.021.
[45] Chai J, Chu FC, Chow TW, Shum NC. Prevalence of malnutrition and its risk factors in stroke patients residing in an infirmary. Singapore Med J 2008;49(4):290–6. https://pubmed.ncbi.nlm.nih.gov/18418520/.
[46] Verlaan S, Ligthart-Melis GC, Wijers SLJ, Cederholm T, Maier AB, de van der Schueren MAE. High prevalence of physical frailty among community-dwelling malnourished older adults-a systematic review and meta-analysis. J Am Med Dir Assoc 2017;18(5):374–82. https://doi.org/10.1016/j.jamda.2016.12.074.
[47] Chou HH, Lai TJ, Yen CH, Chang PS, Pan JC, Lin PT. Sarcopenic obesity tendency and nutritional status is related to the risk of sarcopenia, frailty, depression and quality of life in patients with dementia. Int J Environ Res Public Health 2022;19(5):2492. https://doi.org/10.3390/ijerph19052492.
[48] Nishioka S, Omagari K, Nishioka E, Mori N, Taketani Y, Kayashita J. Concurrent and predictive validity of the mini nutritional assessment ShortForm and the geriatric nutritional risk index in older stroke rehabilitation patients. J Hum Nutr Diet 2020;33(1):12–22. https://doi.org/10.1111/jhn.12699.
[49] Baek MH, Heo YR. Evaluation of the efficacy of nutritional screening tools to predict malnutrition in the elderly at a geriatric care hospital. Nutr Res Pract 2015;9(6):637–43. https://doi.org/10.4162/nrp.2015.9.6.637.
[50] Kris-Etherton PM, Petersen KS, Hibbeln JR, Hurley D, Kolick V, Peoples S, et al. Nutrition and behavioral health disorders: depression and anxiety. Nutr Rev 2021;79(3):247–60. https://doi.org/10.1093/nutrit/nuaa025.
[51] Xu Q, Qian X, Sun F, Liu H, Dou Z, Zhang J. Independent and joint associations of dietary antioxidant intake with risk of post-stroke depression and all-cause mortality. J Affect Disord 2023;322:84–90. https://doi.org/10.1016/j.jad.2022.11.013.
[52] Butt MS, Tariq UIahtisham-Ul-Haq, Naz A, Rizwan M. Neuroprotective effects of oleuropein: recent developments and contemporary research. J Food Biochem 2021;45(12):e13967. https://doi.org/10.1111/jfbc.13967.
[53] Tamburri LM, Hollender KD, Orzano D. Protecting patient safety and preventing modifiable complications after acute ischemic stroke. Crit Care Nurse 2020;40(1):56–65. https://doi.org/10.4037/ccn2020859.
[54] Evidence-based nursing center, West China Hospital, Sichuan University, Nursing Management Professional Committee of Chinese Nursing Association, Chinese Neurosurgical Society,Chinese Medical Association (6). Nursing practice guideline for enteral nutrition in patients with stroke, vol. 21; 2021. p. 628–64. https://doi.org/10.7507/1672-2531.202101115 [in Chinese].