

A Meta-analysis of the Correlation Between Nutritional Risk and Prognosis in Stroke Patients Assessed by Different Scales

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Abstract: Background: Stroke is the second leading cause of death worldwide, with high morbidity and disability rates. In recent years, some scholars have used commonly nutrition screening and evaluation tools to screen and evaluate the nutritional status of patients with stroke. Some scholars have also selected some subjective nutritional evaluation scales to study the prognosis of stroke. However, there is a lack of relevant systems to evaluate the association of different nutritional screening and assessment scales with stroke outcomes. Methods: Pubmed, Embase, Web of science, and Cochrane databases were searched to induce cross-sectional studies of stroke outcomes using nutritional assessment scales. The main indicators and secondary indicators were extracted for meta-subgroup analysis. Results: Thirty articles were included in this study, involving 11604 patients from 14 regions. Two types of data analysis were performed on NRS-2002, MUST, MNA, MNA-SF, SGA, and PG-SGA to predict and evaluate the prognosis of stroke, among which NRS-2002 was 0.44 [95% CI: 0.37–0.52], MUST was 0.58 [95% CI: 0.45–0.70], MNA was 0.29 [95% CI: 0.10–0.52], MNA-SF was 0.11 [95% CI: 0.00–0.42], and SGA and PG-SGA were 0.22 [95% CI: 0.00–0.71]. Continuous data analysis of the mNUTRIC, NRS-2002, and SGA scales used for analysis revealed a value of 13.059 [95% CI: 8.856–17.263]. Conclusion: MNA and MNA-SF are valuable in predicting life activities after stroke in elderly patients and evaluating the stage of recovery after stroke. However, mNUTRIC scale is more effective in the assessment of acute stroke. The results of MUST and NRS-2002 provided a basis for early nutritional intervention. SGA and PG-SGA can be continuously to evaluate nutritional interventions after stroke.

Keywords: Nutritional risk, Prognosis of stroke, Nutritional screening scales, Nutritional assessment scales, Meta-analysis.

1. Foreword

In 2022, the World Stroke Organization (WSO) stated that stroke remains the second leading cause of death in the world, accounting for 11.6% of all deaths. Meanwhile, stroke is the third leading cause of death plus disability, accounting for 5.7% of total disability-adjusted life years (DALYs) globally [1]. According to the Global Burden of Disease Study 2019, stroke is one of the top 10 diseases that cause an increase of the global burden of disease. In total, there are an estimated 12.2 million cases of stroke worldwide and an estimated 101 million stroke victims. Stroke caused 143 million DALYs and 6.55 million deaths [2,3].

Malnutrition is a common and serious problem after stroke. Existing data showed that nutritional status during stroke is related to adverse outcomes after stroke [4,5], while the incidence of post-stroke malnutrition is 6.1%-62% [6]. According to Toni Sabbouh (2018)'s review on the assessment and management of risk factors for malnutrition in patients with stroke, malnutrition in stroke patients on admission was about 20%, which did not show a higher trend due to insufficient recognition and treatment of nutritional management in patients on emphasis. Different methods of nutrition assessment can change the incidence of post-stroke malnutrition within the range of 6.1%-62% [7]. Therefore, some researchers gradually focus on how to apply appropriate methods and tools to screen and assess the nutritional risk of

stroke patients to obtain more accurate nutritional status of stroke patients. Subjective nutritional evaluation may be a good method for medical institutions that lack objective evaluation facilities and are limited by economic factors. At present, there is no internationally recognized gold standard for the diagnosis of post-stroke malnutrition, nor is a specific tool to measure the nutritional status of patients with stroke, mainly due to the lack of specificity for the clinical manifestations of malnutrition[8].

For a long time, some scholars have focused on the correlation between subjective nutritional evaluation and objective nutritional index evaluation to understand the accuracy of nutritional evaluation scale in the assessment of nutritional risk and nutritional status of stroke patient. Eun Joo Kim (2013)[9] evaluated objective and subjective nutritional factors in 35 stroke patients aged 60-89 years using the Mini-Nutritional Assessment (MNA) and the scored patient-generated subjective global assessment (PG-SGA). The objective is to classify malnutrition according to laboratory results, including hematology, biochemistry and anthropometric indicators. The results of nutrition assessment scale in different populations were compared with objective nutrition assessment indexes, and it was found that MNA is one of the most useful tools for screening malnutrition in normal elderly people. However, this approach has certain limitations for stroke patients, and PG-SGA is relatively quick to identify stroke patients with malnutrition compared to MNA. In recent years, more and more scholars began to pay

attention to the correlation between subjective nutrition evaluation scale and stroke prognosis. A retrospective study of 268 patients with acute stroke by Nutritional Risk Screening 2002 (NRS2002) and critical Illness Nutritional Risk Modification Score (mNUTRIC) was conducted by Rui-xin Zhang (2022)[10]. An analysis of ROC curves of NRS 2002 and mNUTRIC in predicting the risk of death in patients with acute stroke showed that MNU TRIC was more effective. However, Xiaoli Chen (2022) [6] et al. multicenter used logistic regression model and ROC curve to analyze whether NRS2002 could accurately predict the incidence of stroke-related infection in patients with hemorrhagic stroke. The results showed that malnutrition and the presence of malnutrition were risk factors for stroke-associated infections, and NRS 2002 was effective in the risk assessment of stroke infection. In summary, the subjective nutrition assessment scale is of high value for the study of the correlation of stroke prognosis. Many studies have confirmed the predictability of different nutrition assessment scales for different outcomes of stroke. To further explore the correlation between subjective nutrition evaluation scale and stroke prognosis is of practical significance for selecting subjective nutrition scale to predict stroke prognosis.

Although some scholars used commonly nutrition screening and evaluation tools to screen and evaluate the nutritional status of stroke patients in recent years, some scholars chose some subjective nutritional evaluation scale to study the prognosis of stroke. However, there is a lack of relevant systems to evaluate the correlation between different nutrition screening and assessment scales and the stroke prognosis. In this study, a meta-analysis was conducted to assess the effectiveness of various nutritional risk screening and nutritional assessment scales in evaluating malnutrition related to stroke and to examine the correlation between nutritional evaluation and stroke outcome to provide reference for nutritional care of patients after stroke

2. Materials and Methods

2.1. Literature retrieval strategy

This study was conducted in compliance with the Cochrane Evaluation Manual and was registered with the PROSPERO platform. Two researchers (He Yunling and Zhao Ling) independently and systematically searched the databases of Pubmed, Embass, Web of science, and Cochrane using subject terms and free space. The search period extended from database inception to November 2022. The search keywords encompassed several terms such as Cerebral stroke, Cerebral infarction, Ischemic stroke, Nutritional risk, and Nutritional status. For instance, in Pubmed, the search expressions are: (((Stroke [Title/Abstract]) OR (Cerebral stroke [Title/Abstract])) OR (Cerebral infarction [Title/Abstract])) OR (Ischemic stroke [Title/Abstract]) AND (((((Nutritional risk[Title/Abstract]) OR (Nutrition risk[Title/Abstract])) OR (Nutritional risks [Title/Abstract])) OR (Nutritional hazard [Title/Abstract])) OR (Nutritional status [Title/Abstract])) OR (Nutrient risk[Title/Abstract])).

2.2. Criteria for inclusion and exclusion of articles

Study subjects: Patients who have had a confirmed stroke-specific changes by cranial CT/MRI and exhibit focal or global neurological deficits based on literature sources [11,12];

Assessment method: The nutritional risk scale was utilized to evaluate the nutritional status and risk of patients after stroke;

Outcome indicators: The main outcome indicators were stroke patients assessments such as MNA, NRS-2002, the Nutrition Universal Screen Tool (MUST), and the Subjective Global Assessment (SGA). The secondary outcome indicators were continuous variables for nutritional risk screening and nutritional status assessment in stroke patients;

Study type: Cross-sectional study;

Exclusion criteria: Firstly, duplicate publications; Secondly, reviews, systematic evaluation and animal experiment, etc.; Thirdly, non-cross-sectional studies; Fourthly, the research content does not match; Fifthly, unable to obtain valid data.

Literature screening and data extraction

According to the inclusion and exclusion criteria, two researchers independently conducted the literature screening and data extraction process. Any discrepancy between them was resolved by a third researcher who carefully evaluated and ruled on the disagreement. The extracted data included first author name, publication date, country or region, baseline characteristics of the study subject, sample size, and outcome measures. When valid data information could not be extracted, the author of the article should be contacted to obtain specific experimental data.

2.3. Literature quality evaluation

The methodological quality of included articles was evaluated in strict accordance with the Cochrane systematic quality evaluation criteria. In case of disagreement, the evaluation was decided by a third party. Evaluation criteria: The quality of observational studies was evaluated using the Agency for Health Care Research and Quality (AHCRO) cross-sectional study evaluation criteria[13]. The evaluation tool 11 items and the evaluation were answered with “Yes”, “No” and “Not clear”, respectively, which were as follows: [1] Whether the source of information was clarified (investigation, literature review)? [2]Are inclusion and exclusion criteria for exposed and non-exposed groups (case and control) list, or are references made to previous publications? [3] Is there a time limit for determining the patient’s identify? [4] If the subjects do not come from a population source from a population source, do they have continuity? [5] Does the evaluator’s subjectivity overshadow other aspects of the subject? [6]Whether any quality assurance assessment (e.g., testing/retesting of primary outcome measures) is described; [7]Whether the reasons for excluding any patient from the analysis are explained; [8]Whether measures to evaluate and/or control confounding factors are described; [9]If possible, whether an explanation was provided of how the lost data was handled in the course of the analysis; [10]Whether the response rate of patients and the integrity of data collection are summarized; [11] If follow-up is available, whether the percentage of expected incomplete data of patients or follow-up results are identified.

2.4. Statistical treatment

STATA SE 15 software was used for statistical analysis of the included studies. The mean difference (MD) represents the measurement data. The relative risk (RR) was calculated, and the 95% confidence interval (CI) was calculated. Q test was used to test the heterogeneity of included studies. When $I^2 \leq 50\%$ and/or $P \geq 0.05$, there was no heterogeneity between included studies, and fixed-effect model was used for analysis.

On the contrary, it indicated that there was heterogeneity between included studies. The causes of heterogeneity were determined through sensitivity analysis and subgroup analysis, and the articles with high sensitivity were excluded. If heterogeneity still existed, the random effect model was used for analysis. $P < 0.05$, the difference was statistically significant.

3. Results

A total of 1035 relevant articles were retrieved and screened layer by layer. Finally, a total of 11,604 patients were included in 30 articles, including 28 English articles [6,9,10,14-37] and 2 Chinese articles [8,38]. Figure 1 showed that the flow chart of literature screening. As shown in Table 1, there were 16 high-quality articles, 14 medium-quality articles, and no low-quality articles.

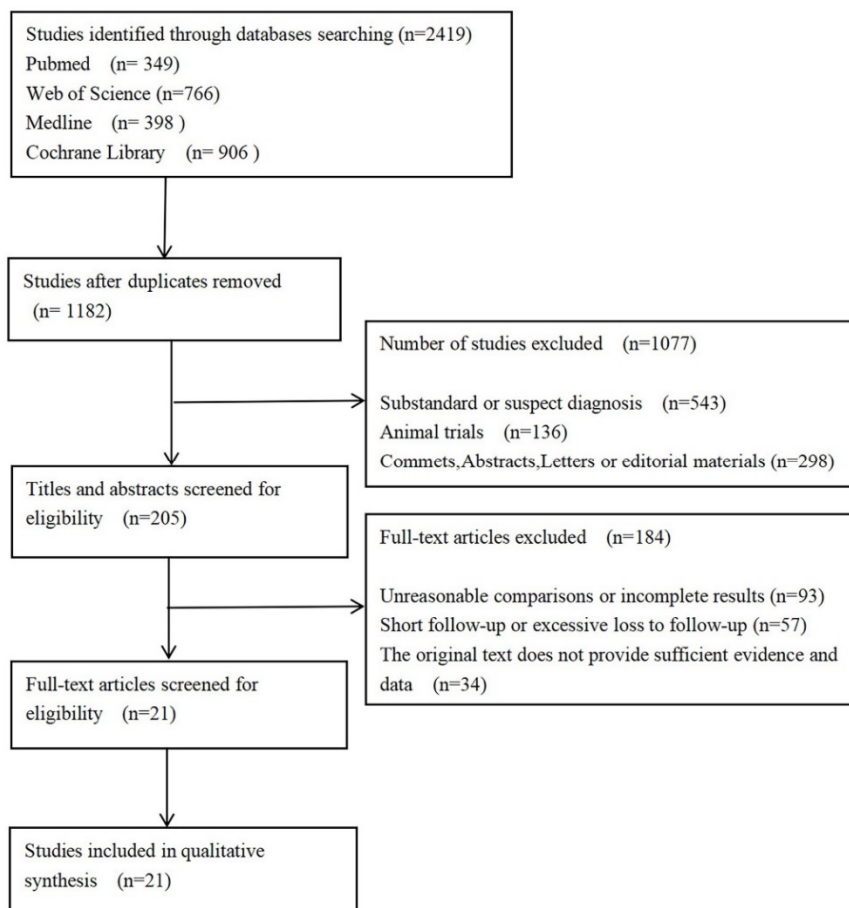


Figure 1. Document screening process

Table 1. The characteristic of included studies

No.	Title	First Author	Nation	Year	Sample size	Sex ratio	Age	Outcome	AHRQ
1	Dietary intake, nutritional status and rehabilitation outcomes of stroke patients in hospital	W. F. R. Nip	UK	2011	100	Male: 47% Female: 53%	69 (15)	MNA	8
2	Dysphagia, Nutrition, and Hydration in Ischemic Stroke Patients at Admission and Discharge from Acute Care	Michael A. Crary	US	2013	67	Male: 43% Female: 57%	65.7	MNA	8
3	The Clinical Significance of the Mini-Nutritional Assessment and the Scored Patient-Generated Subjective Global Assessment in Elderly Patients With Stroke	Eun Joo Kim,	Korea	2013	35	Male: 57.1% Female: 42.9%	60~89	MNA; PG-SGA	5
4	Malnutrition and Risk of Malnutrition in Patients With Stroke: Prevalence During Hospital Stay	Machteld J. Mosselman	Netherlands	2013	73	Male: 59% Female: 31%	65	MNA	6
5	The Long-term Nutritional Status in Stroke Patients and its Predictive Factors	Julie Paquereau	France	2014	71	Male: 50.7% Female: 49.3%	39~81	MNA-SF	8
6	Full Implementation of Screening for Nutritional Risk and Dysphagia in an Acute Stroke Unit: A Clinical Audit	Margitta T. Kampman	Norway	2015	86	Male: 58.7% Female: 41.3%	62 (OR=21)	NRS 2002	5
7	Risk of Malnutrition Is an Independent Predictor of Mortality, Length of Hospital Stay, and Hospitalization Costs in Stroke Patients	Filomena Gomes	UK	2015	543	Male: 51% Female: 49%	75	MUST	8
8	A survey on nutritional risk, malnutrition and nutritional support of patients with cerebral infarction and cerebral hemorrhage	Li Mengjin	China	2016	605	Male: 64.5% Female: 35.5%	62.2±13.4	NRS 2002	8

in a tertiary hospital in Shenzhen									
9	Functional performance, nutritional status, and body composition in ambulant community-dwelling individuals 1–3 years after suffering from a cerebral infarction or intracerebral bleeding	Birgit Vahlberg	Sweden	2016	134	Male: 69% Female: 31%	74 ± 5.0	MNA-SF	8
10	Malnutrition in Acute Stroke Patients Stratified by Stroke Severity- A Hospital Based Study	Dong-Yi Hsieh	Taiwan, China	2017	231	Male: 62.3% Female: 37.7%	64.3 ± 11.1	MNA	6
11	Relationship between nutritional risk and cognitive score in patients with acute stroke	ZhangHua	China	2017	145	Male: 100% Female: 0.0%	67.04±8.95	NRS 2002	8
12	Research on the nutrition and cognition of high-risk stroke groups in community and the relevant factors	N.-N. ZHAO	China	2017	1023	Male: 46.3% Female: 53.7%	40~80	MNA; MNA-SF	8
13	Impact of Premorbid Malnutrition and Dysphagia on Ischemic Stroke Outcome in Elderly Patients: A Community-Based Study	Fereshteh Aliasghari	Iran	2018	253	Male: 52.6% Female: 47.4%	74.42±7.8	MNA	6
14	Malnutrition Rate in Stroke Patients on Admission	Eda Çoban	Turkey	2019	318	Male: 55% Female: 45%	66.16±14.32	MNA; NRS 2002	4
15	Controlling Nutritional Status (CONUT) Score as a Predictor of All-Cause Mortality at 3 Months in Stroke Patients	Fidel Lo'pez Espuela	Spain	2019	164	Male: 51.2% Female: 48.8%	77.7 (SD =7.0)	MNA; CONUT	4
16	Test-retest reliability of the Mini Nutritional Assessment and its relationship with quality of life in patients with stroke	Shu-Chi Lin	Taiwan, China	2019	59	Male: 62.7% Female: 37.3%	71.3±14.7	MNA	6
17	Energy Intake at Admission for Improving Activities of Daily Living and Nutritional Status among Convalescent Stroke Patients	Ai NISHIYAMA	Japan	2019	290	Male: 50.0% Female: 50.0%	78.1±7.8	MNA-SF	8
18	Being at risk of malnutrition predicts poor outcomes at 3 months in acute ischemic stroke patients	Zhong-ming Cai	China	2020	572	Male: 60.1% Female: 39.9%	67.8	NRS-2002; CONUT	8
19	Concurrent and predictive validity of the Mini Nutritional Assessment Short-Form and the Geriatric Nutritional Risk Index in older stroke rehabilitation patients	S. Nishioka	Japan	2019	420	Male: 59.3% Female: 40.7%	78.1±7.9	MNA-SF ; GNRI	8
20	Impact of nutritional status, muscle mass and oral status on recovery of full oral intake among stroke patients receiving enteral nutrition: A retrospective cohort study	Shinta Nishioka	Japan	2019	113	Male: 51.3% Female: 48.7%	77 (66~83)	MNA-SF	6
21	Does the nutritional status of acute stroke patients affect the neurological status in the early post-stroke period?	Krzysztof Wierzbicki	Poland	2019	128	Male: 48.4% Female: 51.6%	70.9±10.27	SGA ; NRS2002	4
22	Nutritional status as a predictor of comprehensive activities of daily living function and quality of life in patients with stroke	Ya-Chen Lee	Taiwan, China	2021	82	Male: 63.4% Female: 36.6%	74.0±11.3	MNA; MNA-SF	8
23	Subjective global assessment of malnutrition and dysphagia effect on the clinical and Paraclinical outcomes in elderly ischemic stroke patients: a community-based study	Mahsa Mahmoudin ezhad	Iran	2021	349	Male: 53.4% Female: 46.6%	70.91 ± 11.07	PG-SGA	6
24	Impact of malnutrition on post-stroke cognitive impairment in convalescent rehabilitation ward inpatients	Keita Tsutsumiuchi	Japan	2020	90	Male: 52.2% Female: 47.2%	75.0±8.7	MNA-SF	5
25	Comparing the prognostic significance of nutritional screening tools and ESPEN-DCM on 3-month and 12-month outcomes in stroke patients	Manman Zhang	China	2020	593	Male: 60.0% Female: 40.0%	67.3±12.0	CONUT ; MUST; NRS-2002	4
26	Comparing the prognostic significance of nutritional screening tools and ESPEN-DCM on 3-month and 13-month outcomes in stroke patients	Manman Zhang	China	2020	593	Male: 60.0% Female: 40.1%	67.3±12.1	CONUT ; MUST; NRS-2003	5
27	Nutritional risk screening 2002 scale and subsequent risk of stroke-associated infection in ischemic stroke: The REMISE study	Xiaoli Chen	China	2022	594	Male: 63.6% Female: 36.4%	74.0 (11.3)	NRS-2002	8
28	Association of risk of malnutrition with adverse outcomes and early support on discharge in acute stroke patients without prestroke disability: A multicenter, registry-based cohort study	David Fluck	UK	2022	2962	Male: 51.1% Female: 48.9%	70.91 (11.07)	NUST	4
29	Depressive symptoms are associated with sarcopenia and malnutrition in older adults	Gulru ULUGGER ER AVCI	Turkey	2022	447	Male: 61.86% Female: 38.14%	75 (8.7)	MNA	8
30	Depressive symptoms are associated with sarcopenia and malnutrition in older adults	Gulru ULUGGER ER AVCI	Turkey	2022	447	Male: 61.86% Female: 38.15%	75 (8.8)	MNA	9
31	Depressive symptoms are associated with sarcopenia and malnutrition in older adults	Gulru ULUGGER ER AVCI	Turkey	2022	447	Male: 61.86% Female: 38.16%	75 (8.9)	MNA	10

3.1. Main indicators

3.1.1. Nutrition Screening Scale

9 articles [6,10,18,24,28,35,36,38,39] (3729 cases) used NRS-2002 for nutritional screening of stroke patients. Meta-analysis showed that there was heterogeneity among the research results ($I^2=98.06%$, $> 50%$ and $P<0.1$ of Q test), and random effects model was used for analysis. In this study, the sensitivity analysis of 9 articles showed that the researches of

Rui-xin Zhang, Xiaoli Chen, and Ting Liu had strong impacts on heterogeneity. After deleting these literatures, the heterogeneity test was conducted again, and the remaining six articles still showed heterogeneity ($I^2=92.22%$, $> 50%$, and $P < 0.1$ for Q test). Therefore, the researches of Rui-xin Zhang, Xiaoli Chen, and Ting Liu were not excluded. The random effects model was used for meta-analysis (Figure 2).

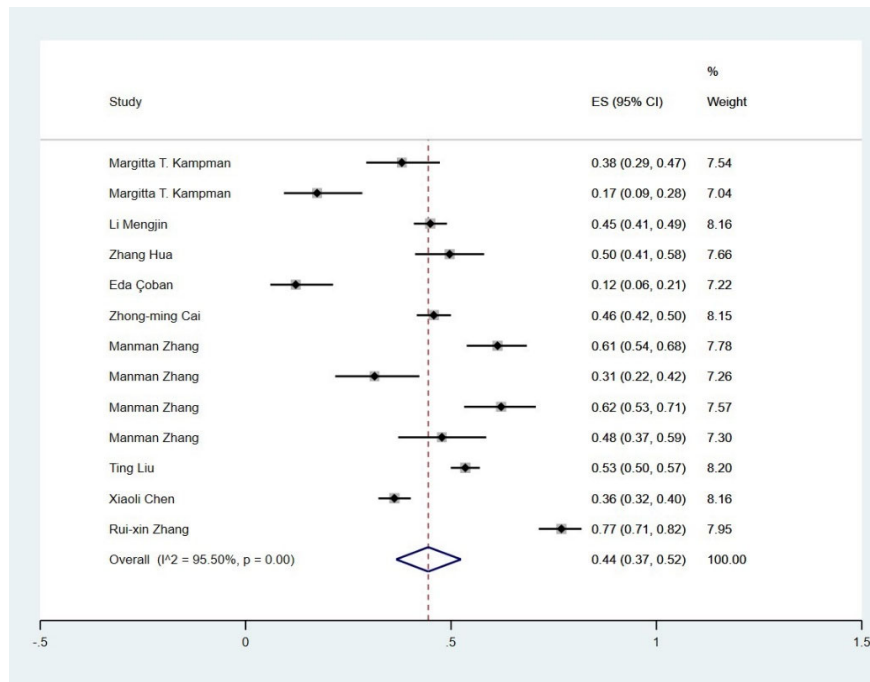


Figure 2. The forest map of NRS-2002 for nutritional screening of stroke patients

4 articles [22,29,30,34] (1646 cases) used the MNA-SF scale to screen nutrition for patients with stroke. The results of meta-analysis showed that there was heterogeneity between the results of each study ($I^2=99.41%$, $> 50%$, and $P<0.1$ of Q Meta). The random effect model analysis and sensitivity analysis of four articles revealed that the research of N.-N. ZHAO had a strong influence on heterogeneity. After

the article was deleted, the heterogeneity test was conducted again, and it was found that the remaining three articles still had heterogeneity ($I^2=98.69%$ was greater than 50%, and $P=0.00$ of Q test was less than 0.1). Therefore, the research of N.-N. ZHAO was not excluded. The random-effect model was used for meta-analysis (Figure 3).

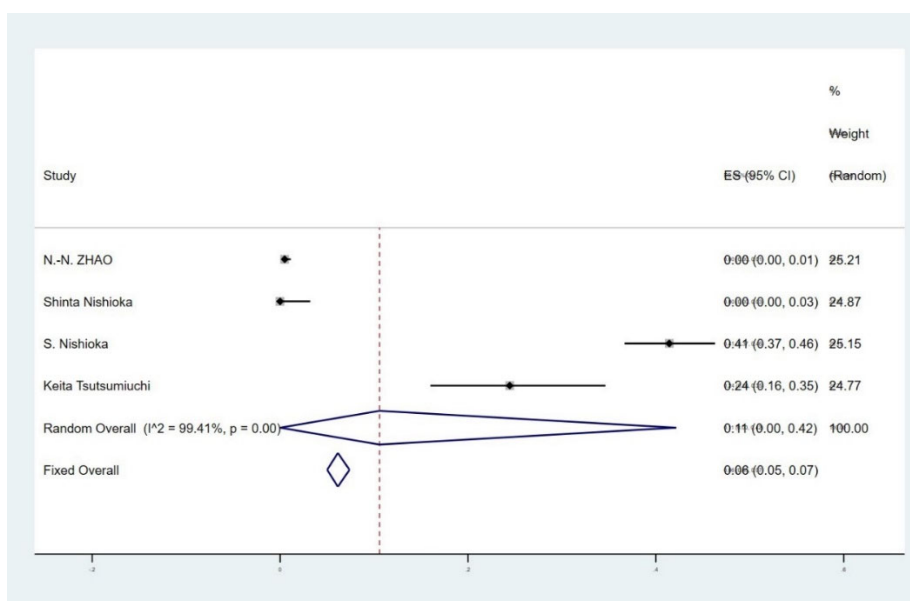


Figure 3. The forest map of MNA-SF for nutritional screening of stroke patients

3 articles[19,35,40](4,569 cases) used the MUST scale to screen nutrition for patients with stroke. The results of the meta-analysis showed that there was heterogeneity between the results of each study ($I^2=98.06\%$, $>50\%$, and $P<0.1$ of Q Meta). The random effect model analysis and sensitivity analysis of three articles in this study revealed that the research of David Fluck had a strong effect on heterogeneity.

After the article was deleted, the heterogeneity test was conducted again, and it was found that the remaining two articles still had heterogeneity ($I^2=98.02\%$, $>50\%$, and $P<0.1$ for Q test). Therefore, the research of David Fluck was not excluded. The random-effect model was used for meta-analysis (Figure 4).

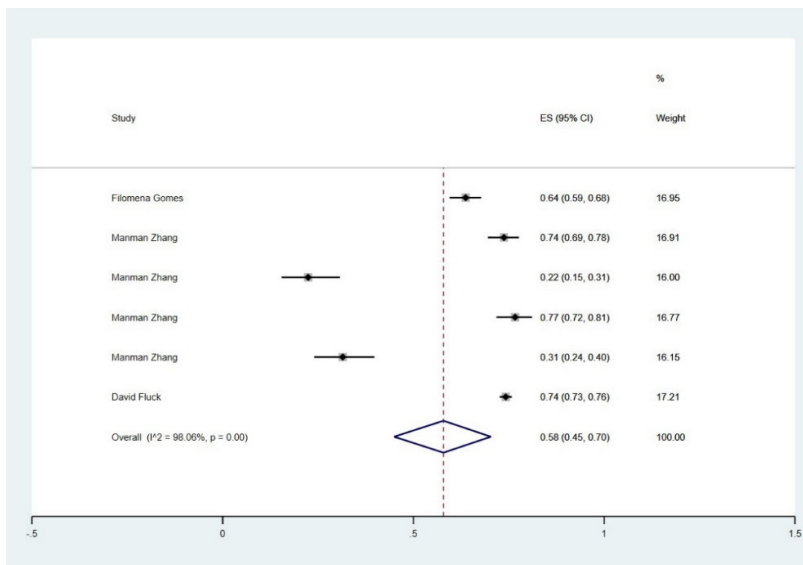


Figure 4. The forest map of the MUST scale for nutritional screening of stroke patients

3.2. Nutrition Assessment Scale

8 articles [9,16,17,21-25](1999 cases) measured the nutritional status of patients with stroke using MNA scale and analyzed the correlation between prognosis and nutritional status. The results of the meta-analysis showed that there was heterogeneity between the study results ($I^2=98.92\%$, $>50\%$, and $P<0.1$ of Q Meta). A sensitivity analysis of eight articles in this study revealed that the research of N.-N. ZHAO had a greater impact on heterogeneity. After the article was deleted, the heterogeneity test was conducted again, and it was found that the remaining seven articles still had heterogeneity

($I^2=93.66\%$ was greater than 50%, and $P=0.00$ of Q test was less than 0.1). Therefore, the research of N.-N. ZHAO was not excluded. The random-effect model was used for meta-analysis (Figure 5).

3 articles [9,33,36](1169 cases) used SGA and PG-SGA scale to measure the nutritional status of patients with stroke and analyze the correlation between prognosis and nutritional status. The results of the meta-analysis showed that there was heterogeneity between the study results ($I^2=99.54\%$, $>50\%$, and $P<0.1$ of Q Meta). The random effect model was adopted for analysis (Figure 6).

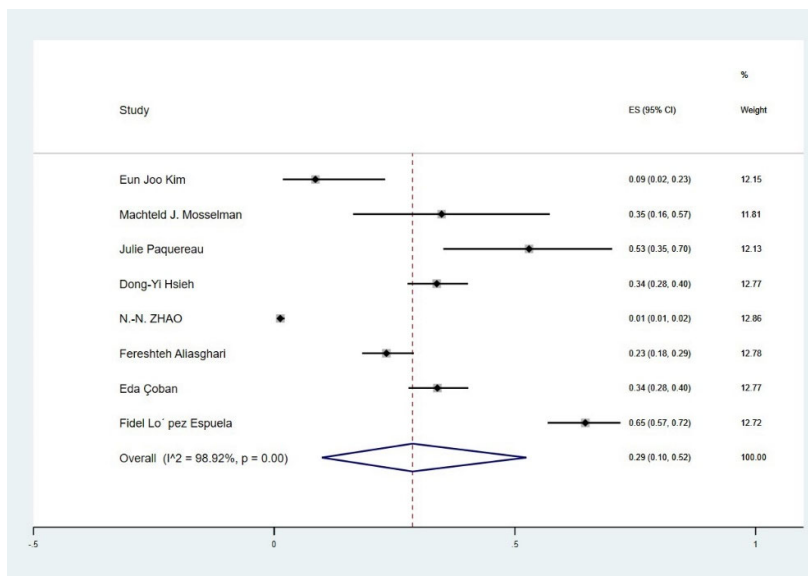


Figure 5. The forest map of using MNA scale to measure the nutritional status of patients with stroke

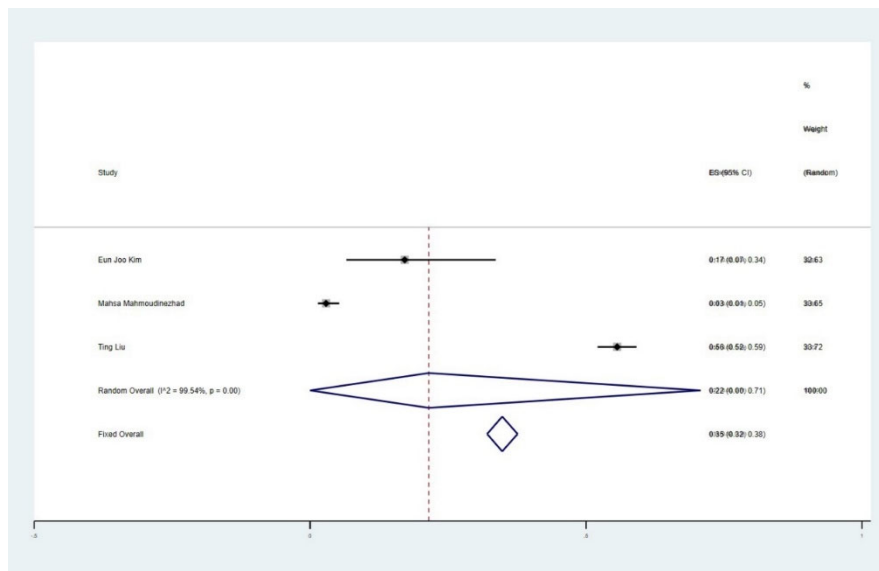


Figure 6. The forest map of using SGA and PG-SGA scale to measure the nutritional status of patients with stroke

3.3. Secondary indicators

3.3.1. Rating scale continuous variable

A total of 9 articles in this study [14,15,20,27,32,36-38] (3365 cases) were included in this study for heterogeneity. The results ($I^2=99.9\%$, $>50\%$ and $P<0.1$ of Q test) indicated that there was significant heterogeneity among the articles selected in this study, so random effects were selected for meta-analysis. No articles significantly interfered with the

results of meta-analysis, indicating that the stability of this study was good. According to the meta-analysis based on random effects, the effect quantity summarized in the 9 studies was 13.059, and the 95% confidence interval was 8.856-17.263, which was statistical significance ($z=6.090$, and $p=0.00$). The nutritional risk assessment scale was significantly correlated with stroke prognosis (correlation degree=13.059). Specific information was shown in the forest map (Figure 7).

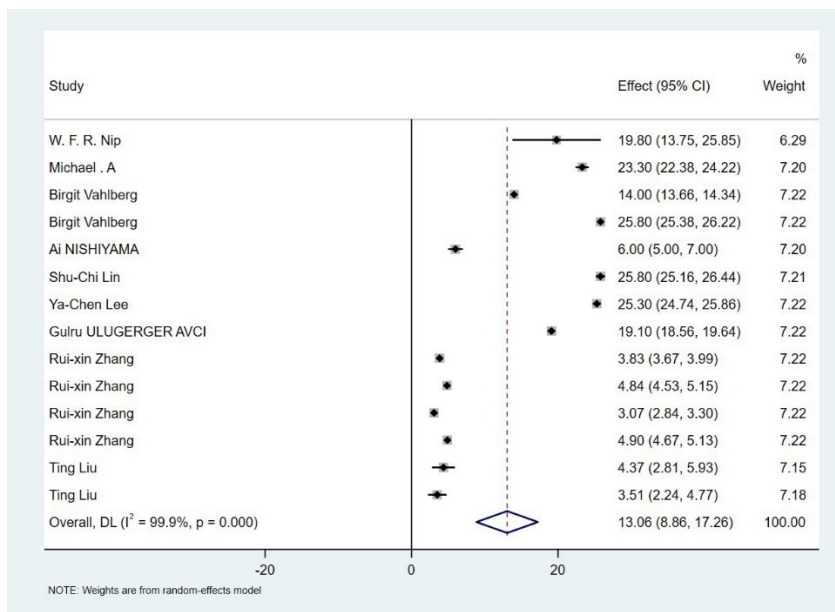


Figure 7. The forest map of rating scale continuous variable

4. Discussion

The subgroup analysis results of the MNA scale in this study showed that the MNA scale had poor predictability in measuring the nutritional status of stroke patients and predicting the prognosis of stroke patients, which was consistent with the results of the included articles in this meta-analysis. The included literature indicated that the MNA scale was significantly effective in the assessment of malnutrition in the elderly, but has certain limitations for elderly stroke

patients. It may be due to lower specificity in older stroke patients due to the decreased mobility and dysfunction (such as aphasia). At the same time, the applicability of MNA for patients with acute stroke was low, but its repeated use to assess the nutritional status of patients with stroke has the reliability of retest. Therefore, MNA was reliable in evaluating the nutritional status of stroke convalescent patients [9,16,23,26]. MNA-SF was a reduced fraction of MNA and was used clinically as a tool for nutritional screening.

According to the results of a multicenter study of 1196 community stroke patients by N.-N. ZHAO (2017), MNA and MNA-SF were used to measure community stroke patients. Compared with MNA, MNA-SF scale has lower sensitivity, higher specificity, higher true-negative rate and lower false-positive rate in the community stroke population. Among stroke patients in the community, who were assessed as malnourished or at risk of malnutrition were less likely to be rated as normal by their Mnas. Therefore, MNA-SF was suitable for populations with higher prevalence of malnutrition. Ya-Chen Lee (2021) studied the correlation between the activities of daily living (ADL) and MNA-SF and MNA scales in a single center study of 82 patients with stroke, which found a significant positive correlation between MNA and MNA-SF scores of patients with stroke and comprehensive ADL. MNA and MNA-SF can predict the activities of living of stroke patients. Therefore, stroke patients with good nutritional status assessed by MNA and MNA-SF may have higher ADL function[22,32].

NRS-2002 is a nutrition screening tool recommended by the European Society for Parenteral Nutrition (ESPEN). In this study, the results of the subgroup analysis of NRS-2002 scale showed that it had a good predictive effect of short-term adverse outcomes in some patients with acute stroke, which was consistent with the good prediction value of NRS-2002 for 3-month and 12-month adverse outcomes in patients with acute hemorrhagic stroke in the included articles. Clinical nurses could use NRS-2002 to screen the risk of stroke patients upon admission, and clinicians could take timely and effective interventions according to NRS-2002 measurement results [28,35,38].

The results of the subgroup analysis for the assessment of MUST in this study were similar to those in the included literature studies, which showed good predictability for some aspects of stroke prognosis. Established risk of malnutrition MUST be assessed as an important independent predictor of mortality, service level and hospitalization cost at 6 months after stroke. It was valuable for using MUST to evaluate the prognosis of stroke patients with nutritional support. The MUST program includes a feature that directly asks patients about any serious medical conditions, similar to NRS-2002. Such evaluation program gives both MUST and NRS-2002 considerable sensitivity and specificity in predicting stroke outcomes. As a result, MUST and NRS-2002 were highly accurate in assessing the prognosis of stroke patients with malnutrition[19,35].

The results of continuous Meta analysis in this study showed that the mNUTRIC, NRS-2002 and SGA scales showed that the mNUTRIC, NRS-2002 and SGA scales were significant correlated with the prognosis of stroke, indicating that the above scales were effective in predicting the prognosis of stroke. The mNUTRIC score was a tool recommended by some guidelines for nutritional risk screening in critically ill patients and it was valuable in predicting mortality risk prediction of ICU patients. Rui-xin Zhang (2022) found that NRS-2002 and mNUTRIC were effective in predicting the risk of inpatient death of patients with acute stroke, and mNUTRIC was superior to NRS-2002[31,36].

SGA was a recommended method for evaluating a patient's nutritional status, including history collection and physical examination. PG-SGA, which was revised based on SGA, has the advantages of evaluating a variety of gastrointestinal symptom records to reflect the food intake of patients in the

past two weeks and one month, which can help to further evaluate the causes of malnutrition. The problem of PG-SGA were mainly constructed from the experience of surgical patients and designed to solve medical problems. Therefore, the scale was more sensitive to small changes after post-stroke nutritional intervention[9,23].

This meta-analysis has the following deficiencies: Firstly, all the Chinese and English articles included in this study were retrieved through regular databases, and the number of retrieved articles was limited. Some articles have certain deficiencies in the quality evaluation of AHRQ, for example, Eda Çoban (2019)[24] did not explicitly list the inclusion and exclusion criteria of research subjects. Secondly, according to the currently included articles, some articles have publication bias, and more researchers were needed to further demonstrate the results.

In summary, MNA and MNA-SF are valuable in predicting post-stroke life activity in elderly patients and evaluating the recovery period of stroke patients. However, mNUTRIC scale is more effective in the assessment of acute stroke. The results of MUST and NRS-2002 provided a basis for early nutrition intervention. SGA and PG-SGA can be continuously used to evaluate nutritional interventions after stroke.

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