PLOS ONE

RESEARCH ARTICLE

Risk factors of dysphagia in patients with ischemic stroke: A meta-analysis and systematic review

Cui Yang[1], **Yun Pan**[2]*

1 Department of Neurology, The First People's Hospital of Lianyungang, The Affiliated Lianyungang Hospital of Xuzhou Medical University, Jiangsu, China, **2** Division of Rheumatology, The First People's Hospital of Lianyungang, The Affiliated Lianyungang Hospital of Xuzhou Medical University, Jiangsu, China

* ujnzlyk@163.com

Citation: Yang C, Pan Y (2022) Risk factors of dysphagia in patients with ischemic stroke: A meta-analysis and systematic review. PLoS ONE 17(6): e0270096. https://doi.org/10.1371/journal.pone.0270096

Editor: Massimiliano Toscano, Universita degli Studi di Roma La Sapienza, ITALY

Received: February 24, 2022

Accepted: June 4, 2022

Published: June 16, 2022

Data Availability Statement: All relevant data are within the paper.

Funding: The authors received no specific funding for this work.

Competing interests: The authors have declared that no competing interests exist.

Abbreviations: BDST, Burke Dysphagia Screening Test; BSE, bedside assessment evaluation; CI, confidence intervals; CNKI, China National Knowledge Infrastructure; FEES, fiberoptic endoscopic evaluation of swallowing; NOS,

Abstract

Background

Dysphagia is a common yet serious complication in stroke patients. We aimed to conduct a meta-analysis and systematic review to evaluate the risk factors of dysphagia in patients with ischemic stroke, to provide insights to the clinical treatment and nursing care of dysphagia.

Methods

We searched PubMed, Embase, Cochrane Library, Web of Science, China National Knowledge Infrastructure (CNKI) and Wanfang Database, China Biomedical Literature Database (CBM) for studies on dysphagia in patients with ischemic stroke up to January 31, 2022. The quality of the literature was evaluated using the Newcastle-Ottawa scale. Meta-analysis was performed using RevMan 5.3 software.

Results

A total of 10 studies involving 4637 ischemic stroke patients were included, 1183(25.51%) patients had dysphagia after stroke. The synthesized outcomes showed that elder age (SMD = 0.42, 95%CI:0.34–0.50), hypertension (OR = 1.96, 95%CI:1.48–2.61), diabetes (OR = 1.83, 95%CI:1.47–2.28), brainstem stroke (OR = 2.12, 95%CI:1.45–3.09) were associated with dysphagia in patients with ischemic stroke (all P<0.05). There was no significant difference in the gender between dysphagia and no dysphagia patients (OR = 1.07, 95% CI:0.91–1.27, P = 0.40). Egger regression tests indicated there were no significant publication biases in the synthesized outcomes (all P>0.05).

Conclusions

Elder age, hypertension, diabetes and brainstem stroke are associated with the development of dysphagia in patients with ischemic stroke. Attention should be paid to the

assessment and early intervention of those risk factors for dysphagia to improve the prognosis of stroke patients.

Newcastle-Ottawa scale; OR, odds ratios; PRISMA, preferred reporting items for systematic reviews and meta-analyses; SMD, standardized mean differences; SSA, standardized swallowing assessment; VFSS, video fluoroscopy swallowing study; WST, water swallowing test.

Background

Stroke has become the leading cause of death in the world, of which ischemic stroke is the most common type of stroke, accounting for about 80% stroke [1, 2]. Dysphagia is one of the common complications after stroke, the incidence of dysphagia in acute stroke patients is 34.11%-80.05% [3, 4]. Dysphagia can significantly increase the risk of aspiration, pneumonia, and prolong hospital stay in stroke patients [5, 6]. Additionally, dysphagia is an independent risk factor for malnutrition, poor functional recovery, and post-stroke depression [7]. Therefore, the prevention and treatment of dysphagia after stroke is of great significance to the quality of life and prognosis of stroke patients.

Identifying risk factors for dysphagia is critical for the prevention and treatment of dysphagia after stroke. Previous studies [8, 9] have pointed out that the occurrence of dysphagia in stroke patients is affected by many factors. Among them, age, history of cerebrovascular disease, infarction site and other important factors that may affect the occurrence of dysphagia. Besides, the patient gender and muscle strength, etc. may also affect the occurrence of dysphagia, but research results are inconsistent. At present, for the investigations and researches on dysphagia in patients with ischemic stroke, due to the differences in study population, the screening and diagnosis methods of dysphagia, the sample size and other factors, the results are also quite different. Therefore, this meta-analysis aimed to conduct a data synthesis analysis and systematic review of the current risk factors for dysphagia in ischemic stroke patients, to evaluate the risk factors for dysphagia in ischemic stroke patients, to provide evidence support for the clinical prevention, treatment and nursing care of dysphagia.

Methods

Ethical approval was not necessary since our study was a meta-analysis and systematic review. This meta-analysis was conducted and reported according to the guidelines for preferred reporting items for systematic reviews and meta-analyses (PRISMA statement) [10]. In this study, all methods were performed in accordance with the relevant guidelines and regulations.

Inclusion and exclusion criteria

The inclusion criteria for this meta-analysis were as follows: (1) The study population were patients with ischemic stroke diagnosed by head CT or MRI, and the patients were aged $\geq$18 years; (2) The swallowing function assessment tool was used to determine whether the patients had dysphagia. (3) cohort study or case-control study design. (4) The publication language of the article was limited to Chinese and English. The literature exclusion criteria for this meta-analysis were as follows: (1) patients with non-ischemic stroke; (2) duplicate publications; (3) studies with incomplete information or data for extraction; (4) literature with low quality.

Literature search

The two authors searched PubMed, Embase, Cochrane Library, Web of Science, China National Knowledge Infrastructure (CNKI) and Wanfang Database, China Biomedical Literature Database (CBM) for studies on dysphagia in patients with ischemic stroke. The search

time limit of each database was from the establishment of the database to January 31, 2022. We combined subject terms and free terms to conduct the literature search. The search terms used in this meta-analysis were ("stroke" OR "ischemic stroke" OR "brain ischemia" OR "cerebral infarction" OR "intracranial embolism" OR "cerebral embolism") AND ("'swallowing disorder" OR "swallowing dysfunction" OR "dysphagia").

Literature screening and data extraction

Two authors independently searched the literature according to the retrieval strategy. We initially screened the literature according to the title and abstract, and then we read the full text for re-screening and cross-checking. If there was any disagreement, it would be resolved through negotiation. The contents of the literature data extracted in this meta-analysis included the first author, study site, sample size, number of cases of dysphagia, details of dysphagia assessment methods (tools, evaluators, assessment timepoint), related risk factors for dysphagia, and research conclusions.

Methodological quality assessment

Two authors independently used the Newcastle-Ottawa scale (NOS) [11] to evaluate the quality of included studies. If any disagreements occurred during the evaluation process, they were resolved through discussion. The NOS scale evaluated the quality of the literature in three aspects: patient selection (4 items, 4 points), comparability (1 item, 2 points), and exposure assessment (3 items, 3 points). The total NOS score is 9 points, and literatures with NOS $\geq$ 7 points are generally considered as high-quality.

Data analysis

RevMan 5.3 software was used for statistical analyses in this meta-analysis. Binary outcomes were presented as Mantel–Haenszel-style odds ratios (OR) with 95% confidence intervals (CI). Continuous outcomes were presented as standardized mean differences (SMD). Fixed-effect model was selected in cases of homogeneity (P value of $\chi 2$ test >0.10 and $I^2 < 50\%$), and random-effect model was used in cases of obvious heterogeneity (P value of $\chi 2$ test >0.10 and $I^2 \geq 50\%$). Publication bias were evaluated by using funnel plots, and asymmetry was assessed with Egger regression test. In this meta-analysis, $P<0.05$ was considered that the difference was statistically significant between groups.

Results

Study inclusion

The process of selecting studies is presented in Fig 1. The first search identified 213 potentially relevant reports. Of those identified articles, 9 reports were excluded as duplicates. After viewing the titles and abstracts of the 204 remaining reports, the full texts of 41 reports were retrieved. Among them, 31 studies were excluded with failure to meet criteria. Finally, 10 studies [12–21] were included in this present meta-analysis.

The characteristics of included studies

Of the 10 included studies [12–21], a total of 4637 ischemic stroke patients were involved, and 1183(25.51%) patients had dysphagia after stroke. As presented in Table 1, Of the 10 included studies [12–21], 4 studies were assessed for dysphagia within 24 hours of admission. The dysphagia assessment tools used in the studies mainly included standardized swallowing assessment (SSA), water swallowing test(WST), Burke Dysphagia Screening Test(BDST), video

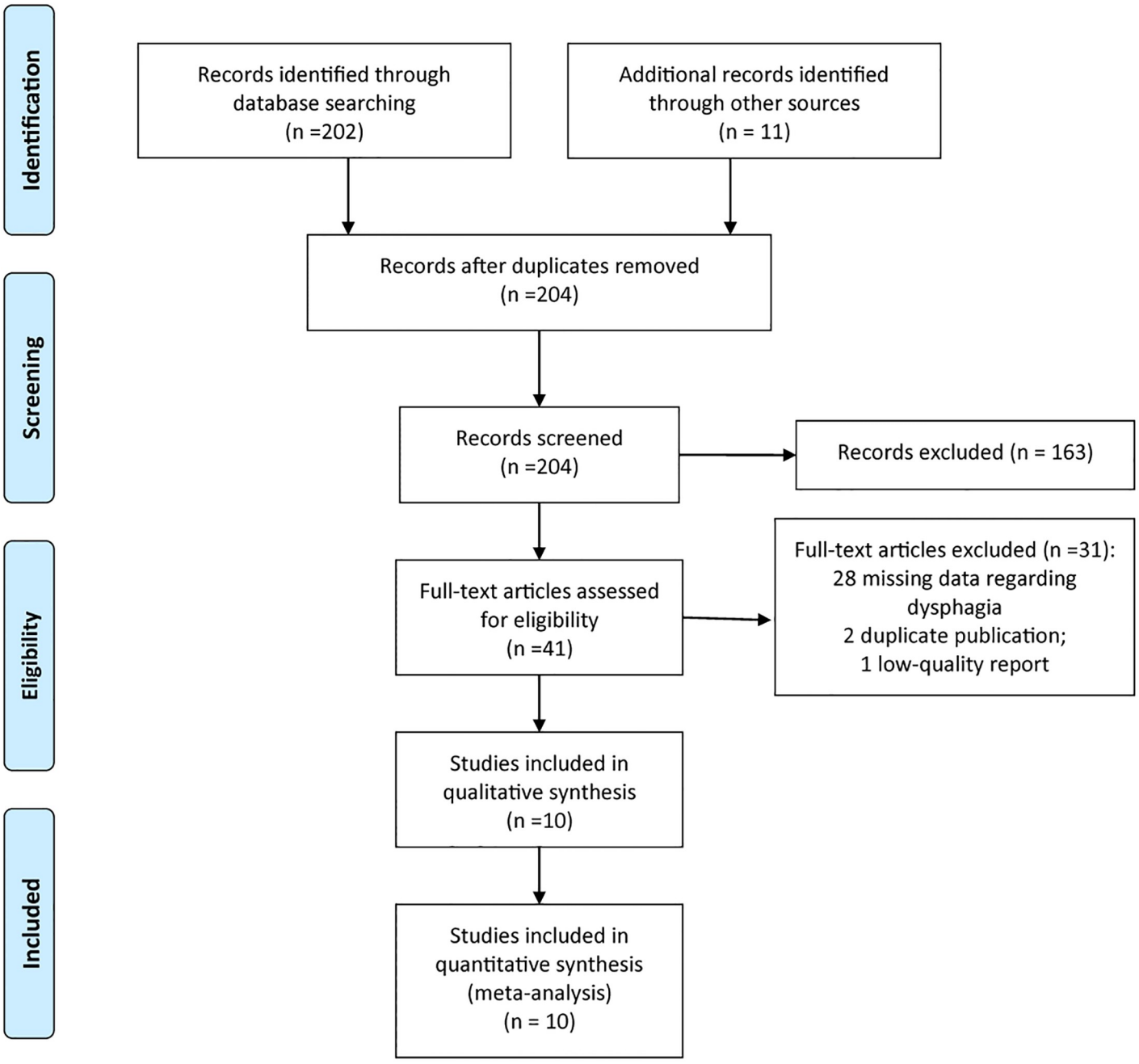

Fig 1. The flow chart of study selection.

https://doi.org/10.1371/journal.pone.0270096.g001

fluoroscopy swallowing study (VFSS), fiberoptic endoscopic evaluation of swallowing(FEES). The influencing factors analyzed in the 10 reports [12–21] mainly included the general demographic data, underlying diseases, disease severity, and stroke site of patients.

The quality of included studies

As indicated in Table 2, the NOS score of 3 papers was rated as 8 points, and 7 papers were rated as 7 points, the quality of the 10 included articles was generally high.

Table 1. The characteristics of included studies.

Study	Country	Sample size	Cases of dysphagia	Swallowing disorder assessment tool	Dysphagia evaluator	Timepoint of dysphagia assessment
Beharry 2019	New Zealand	340	81	BDST	Nurse	24 hours after admission to hospital
Cong 2012	China	496	103	WST	Physician	At the admission to hospital
Flowers 2017	Canada	160	76	Clinical symptom and tool assessment	SLP	Within 14 days after stroke
Hao 2018	China	177	87	SSA	Rehabilitation physician	24 hours after admission to hospital
Henke 2017	Germany	1442	413	Two-step assessment of swallowing function	SLP	24 hours after admission to hospital
Huang 2007	China	563	75	Swallowing disorders clinical screening system	Physician	During the hospital stay
Lapa 2017	Germany	59	14	Clinical swallowing disorder assessment and FEES	SLP	24 hours after admission to hospital
Meng 2021	China	542	202	WST	Rehabilitation technician and stroke rehabilitation specialist nurse	48 hours after admission to hospital
Remesso 2011	Brazil	596	117	Bedside symptom assessment and tool assessment	Medical team	Within 14 days after admission to hospital
Yang 2018	South Korea	262	15	VFSS	Rehabilitation physician	During the hospital stay

Notes: SSA, standardized swallowing assessment; WST, water swallowing test; BDST, Burke Dysphagia Screening Test; VFSS, video fluoroscopy swallowing study; FEES, fiberoptic endoscopic evaluation of swallowing.

https://doi.org/10.1371/journal.pone.0270096.t001

Meta-analysis

Age and dysphagia after stroke 6 studies [12, 15, 16, 18–20] evaluated the relationship between age and dysphagia, and there was no statistical heterogeneity among the studies ($I^2 = 0$, $P = 0.44$). The fixed effect model was used for statistical analysis. The results showed that the risk of dysphagia was higher in stroke patients with elder age (SMD = 0.42, 95%CI:0.34–0.50, $P<0.001$, Fig 2).

Gender and dysphagia after stroke 5 studies [14, 16–19] evaluated the relationship between gender and dysphagia, and there was no statistical heterogeneity among the studies ($I^2 = 20$, $P = 0.28$). The fixed effect model was used for statistical analysis. The results showed that the

Table 2. The NOS score of included studies.

Study	Patient selection	Comparability	Exposure assessment	NOS total score
Beharry 2019	3	2	3	8
Cong 2012	3	2	2	7
Flowers 2017	3	2	2	7
Hao 2018	3	2	3	8
Henke 2017	3	2	2	7
Huang 2007	3	2	2	7
Lapa 2017	3	2	3	8
Meng 2021	3	2	2	7
Remesso 2011	3	2	2	7
Yang 2018	3	1	3	7

https://doi.org/10.1371/journal.pone.0270096.t002

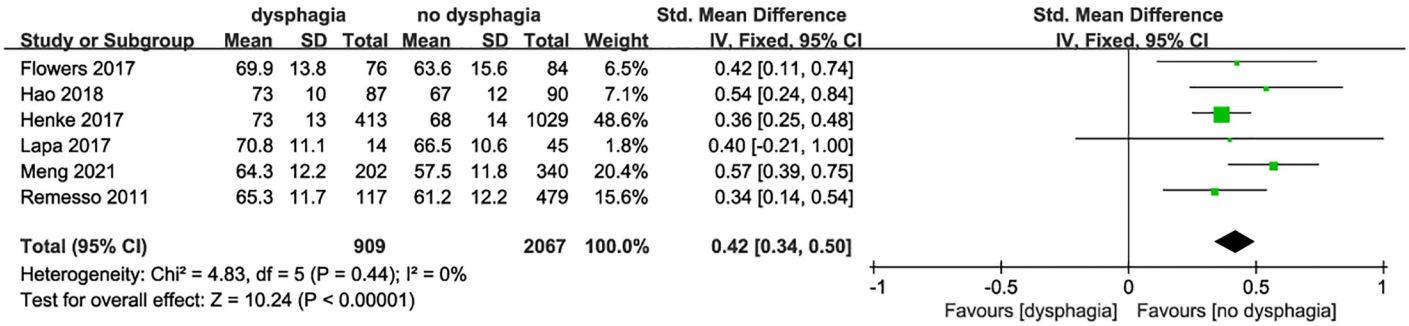

Fig 2. Forest plot for the relationship between age and dysphagia after stroke.

https://doi.org/10.1371/journal.pone.0270096.g002

there was no significant difference in the gender between dysphagia and no dysphagia patients (OR = 1.07, 95%CI:0.91–1.27, P = 0.40, Fig 3).

Hypertension and dysphagia after stroke 3 studies [12, 14, 19] evaluated the relationship between hypertension and dysphagia, and there was no statistical heterogeneity among the studies (I^2 = 0, P = 0.75). The fixed effect model was used for statistical analysis. The results showed that the risk of dysphagia was higher in stroke patients with hypertension (OR = 1.96, 95%CI:1.48–2.61, P<0.001, Fig 4).

Diabetes and dysphagia after stroke 4 studies [12, 14, 19, 20] evaluated the relationship between diabetes and dysphagia, and there was no statistical heterogeneity among the studies (I^2 = 0, P = 0.99). The fixed effect model was used for statistical analysis. The results showed that the risk of dysphagia was higher in stroke patients with diabetes (OR = 1.83, 95%CI:1.47–2.28, P<0.001, Fig 5).

Brainstem stroke and dysphagia after stroke 6 studies [13–15, 19–21] evaluated the relationship between stroke site and dysphagia, and there was no statistical heterogeneity among the studies (I^2 = 0, P = 0.76). The fixed effect model was used for statistical analysis. The results showed that the risk of dysphagia was higher in patients with brainstem stroke (OR = 2.12, 95%CI:1.45–3.09, P<0.001, Fig 6).

Publication of bias and sensitivity analyses

The publication of bias was evaluated with funnel plot and Egger regression test. As indicated in Fig 7, the dots in the funnel plot of synthesized outcomes were evenly distributed, and

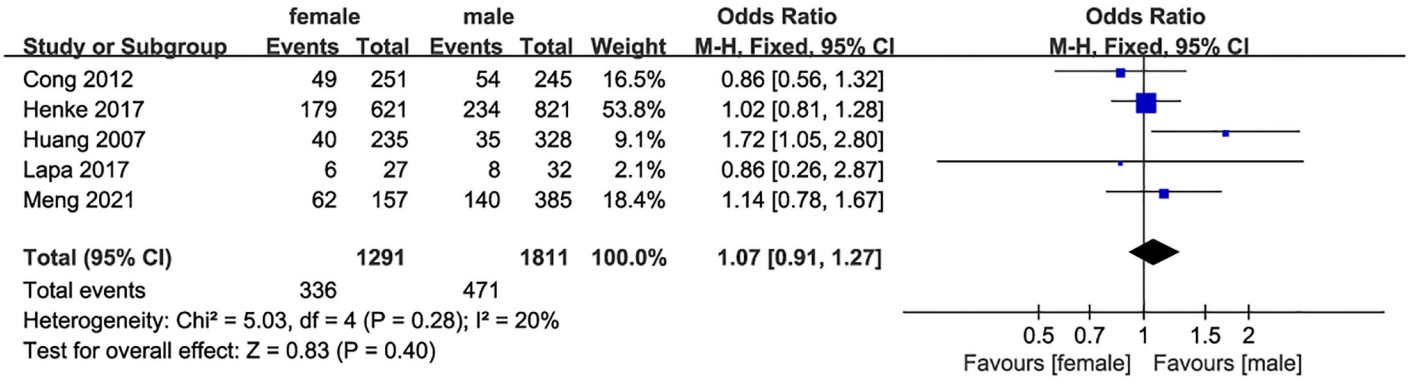

Fig 3. Forest plot for the relationship between gender and dysphagia after stroke.

https://doi.org/10.1371/journal.pone.0270096.g003

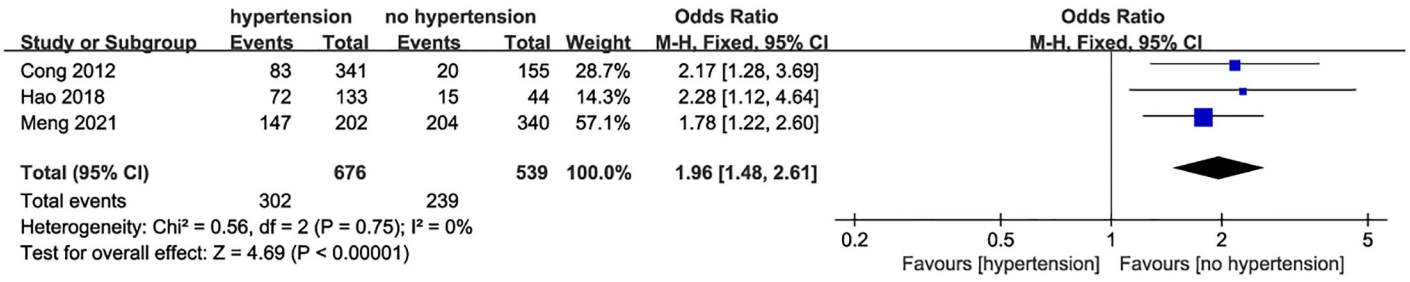

Fig 4. Forest plot for the relationship between hypertension and dysphagia after stroke.

https://doi.org/10.1371/journal.pone.0270096.g004

results of Egger regression test indicated there were no significant publication biases in the synthesized outcomes (all P>0.05).

Sensitivity analyses, which evaluated the impact of one single study on the overall risk estimated by removing one study in each turn, suggested that the overall risk estimates were not substantially changed by any one study.

Discussions

Stroke is a common and frequently-occurring disease of the nervous system, and it is an important cause of death or disability of residents worldwide, and the recurrence rate is high [22, 23]. According to statistics [24, 25], there are about 2 million new stroke patients in China every year, of which 22%-65% of stroke patients are accompanied by dysphagia, the incidence of dysphagia within 3 days of stroke patients is 12%-67%. Aspiration occurs in 10% of patients with dysphagia, and 33% of patients with dysphagia can develop pneumonia, which significantly increased the risk of death [26]. However, many screenings especially bedside assessment evaluation (BSE) are focused on dysphagia without considering aspiration and vice-versa. It's been reported that dysphagia may occur without aspiration [27]. Conversely, high sensitive BSEs designed to detect also aspiration and tested against the FEES [28–30] are more likely to depict the real situation, thus being more useful to design studies on post-stroke aspiration prevention. Therefore, in clinical work, it is important to identify the risk factors for dysphagia to prevent and treat dysphagia after stroke. The results of this meta-analysis suggest that age, hypertension, diabetes, and brainstem stroke are independent risk factors for dysphagia in patients with ischemic stroke, early targeted prevention and nursing care are needed for those patients in clinical settings.

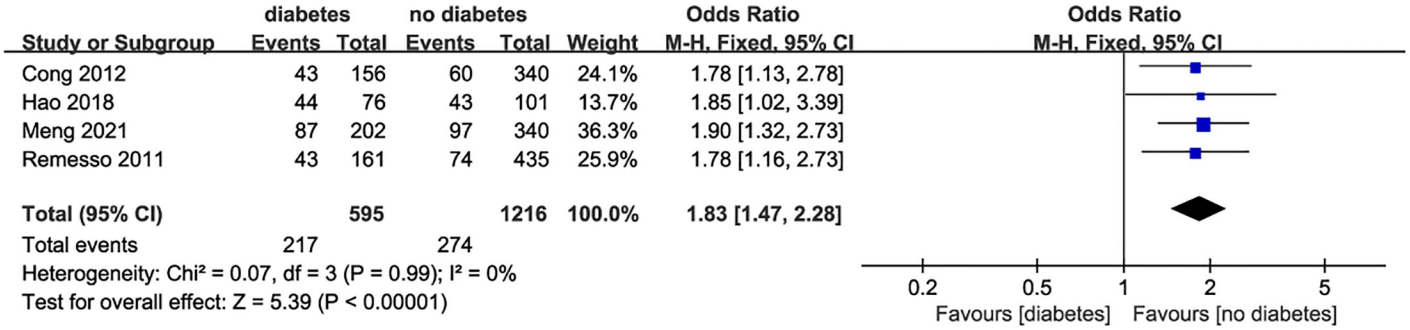

Fig 5. Forest plot for the relationship between diabetes and dysphagia after stroke.

https://doi.org/10.1371/journal.pone.0270096.g005

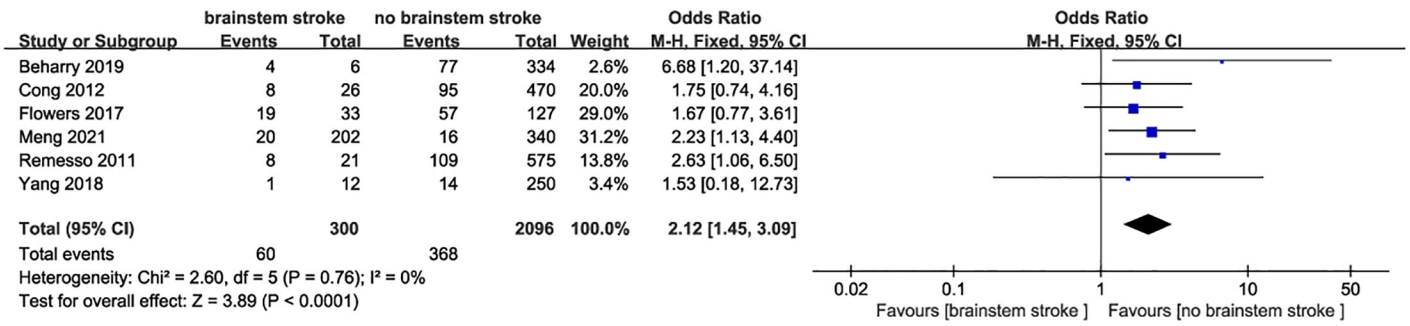

Fig 6. Forest plot for the relationship between brainstem stroke and dysphagia after stroke.

https://doi.org/10.1371/journal.pone.0270096.g006

Previous studies [31–33] have pointed out that dysphagia after stroke is mainly caused by damage to the swallowing cortex center, cortical descending fibers, medulla oblongata swallowing center and extrapyramidal system. The physiological process of dysphagia includes cognitive and psychological disorders, organic lesions and functional abnormalities. The primary lesions of dysphagia after stroke are located in both cerebral cortex or brainstem tracts [34]. Swallowing disorders can occur in all stages from the cognitive stage to the esophageal stage [35]. Patients will experience prolonged oral passage time and pharyngeal swallowing delay, and they are prone to aspiration before and during swallowing [36]. Treatment and nursing care of patients with dysphagia after stroke is a holistic process from swallowing assessment to rehabilitation, emphasizing multidisciplinary participation and comprehensive training [37–39]. The assessment of dysphagia after stroke should be based on the clinical manifestations of patients, and fully consider the advantages of assessment methods, so as to improve the accuracy and effectiveness of dysphagia screening and treatment [40–42].

Age is an important factor affecting patients with dysphagia after stroke. Previous studies [43, 44] have shown that age is a risk factor for dysphagia, and with age increases, the risk of dysphagia in stroke patients also increases, which is consistent with our findings. The possible reasons may be related to the gradual weakening of various body functions as the patient aging, and the weakening of the body function can further lead to the dysfunction of the patient's oral and maxillomandibular system (chewing, swallowing, breathing, and vocalization), thereby causing dysphagia [45, 46]. In addition, older patients have a higher probability of degeneration of advanced cranial nerve function and abnormal swallowing reflex function, which further increases the susceptibility of swallowing dysfunction [27, 47–49]. Due to the weakening of the transport capacity of the tongue muscle and the collapse of the tongue muscle in elderly patients, the food bolus will leak in advance and later, and the oral transport time will be prolonged during the feeding process [50, 51]. Clinical medical workers should fully evaluate the swallowing function of elderly stroke patients with dysphagia, and carry out targeted rehabilitation training to prevent the occurrence of aspiration.

Hypertension and diabetes are not only the risk factors for stroke, but also the risk factors for dysphagia in stroke patients [52, 53]. The results of this study have showed that the incidence of dysphagia in ischemic stroke patients with hypertension and diabetes is significantly higher than that of patients without hypertension and diabetes, which may have a joint effect with chronic diseases affecting the overall function of patients, thereby increasing the risk of dysphagia. Brainstem lesions can affect the sensitivity of the tongue and cheeks, and it may cause swallowing and laryngeal muscle dysfunction, which are the independent risk factors for swallowing dysfunction. It's been reported that patients with brainstem lesions are often

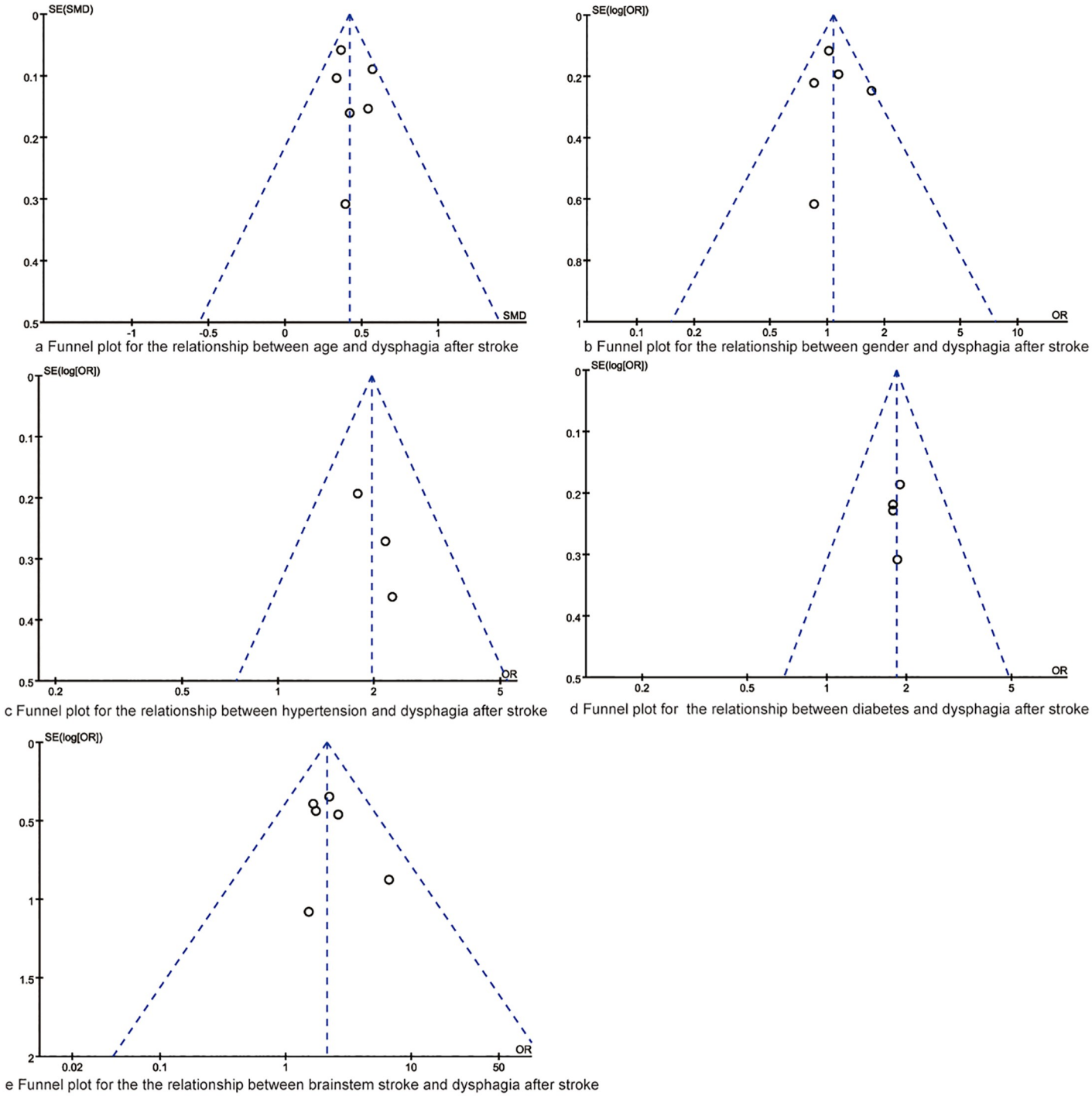

Fig 7. Funnel plots for the synthesized outcomes.

https://doi.org/10.1371/journal.pone.0270096.g007

accompanied by covert aspiration, leading to aspiration pneumonia [54–56]. The results of this meta-analysis have showed that brainstem infarction is a risk factor for dysphagia in patients with ischemic stroke, which may be related to the existence of cranial nerve nuclei in the medulla oblongata that control and regulate the swallowing reflex [57]. We have not found

the gender differences in the occurrence of dysphagia after stroke. However, previous studies [58, 59] have reported that men are at greater risk of dysphagia and pneumonia after stroke than women. Therefore, the gender difference in the occurrence of dysphagia after stroke remains to be further studied in the future.

It must be noted that for silent aspiration, whose detection is usually failed from most BSEs, and that could be of particular relevance for pneumonia after stroke. In fact, by focusing on the overt sign of aspiration to diagnose post-stroke dysphagia, such as cough or voice change, the silent aspiration can be undiagnosed, with a relevant increase in relative risk of pneumonia and poorer stroke clinical outcome. It's been reported that although advances have been made in dysphagia care, prevalent screening and treatment practices remain insufficient to reduce pneumonia and decrease case fatality in dysphagic stroke patients [50]. Besides, in stroke patients who passed low-sensitive screening for dysphagia compared to those who passed high-sensitive ones who can detect also silent aspiration [60]. The stroke severity, as assessed with the NIHSS, dramatically affects the incidence and severity of post-stroke dysphagia. NIHSS is an independent risk factor for swallowing impairment after stroke. Moreover, it is very relevant that an NIHSS $\geq$ 12 has been suggested as the cut-off value to predict, upon admission, those stroke patients who will probably remain dysphagic after 14 days follow-up [16, 28]. Thus, identifying dysphagic patients through a highly accurate screening tool might be crucial in reducing the complications after stroke.

There are certain limitations of this meta-analysis worth considering. First, the studies included in the meta-analysis were all derived from published literature, and gray literature was not included, which may have potential publication bias. Second, there are certain differences in swallowing function assessment time, swallowing function assessment screening tools and risk measurement, etc., which may affect the study results even though we did not find the heterogeneity amongst the synthesized outcomes. Third, we only focused on the population with ischemic stroke, the choice to exclude other types of stroke could be reasonable for increasing the certitude of the results but has also the weakness of limiting the generalizability of results. Finally, the data reported for some other potentially influencing factors in the included studies are very limited. Due to the inconsistent data types of NIHSS scores in the literature included in this meta-analysis, some studies were continuous variables, some studies were categorical variables, and the classification thresholds of NIHSS scores were different, so this study could not analyze the effect of NIHSS scores on dysphagia in stroke patients. Some studies have shown that NIHSS score and muscle strength are independent predictors of dysphagia in patients with acute stroke. The association of these factors with dysphagia after stroke requires further analysis and investigation in the future.

Conclusions

In conclusion, this meta-analysis has found that age, hypertension, diabetes, and brainstem stroke are the independent risk factors for dysphagia in patients with ischemic stroke. In clinical work, high-risk patients for dysphagia in patients with ischemic stroke should be vigilant, comprehensive and systematic evaluation should be carried out as soon as possible, and early intervention and early nursing care should be taken for patients with changes in swallowing function, so as to improve the quality of life of patients.

Author Contributions

Conceptualization: Yun Pan.

Data curation: Cui Yang, Yun Pan.

Formal analysis: Yun Pan.

Investigation: Cui Yang, Yun Pan.

Methodology: Cui Yang.

Project administration: Cui Yang.

Resources: Cui Yang.

Software: Cui Yang, Yun Pan.

Supervision: Yun Pan.

Validation: Cui Yang, Yun Pan.

Visualization: Cui Yang, Yun Pan.

Writing – original draft: Cui Yang, Yun Pan.

Writing – review & editing: Cui Yang, Yun Pan.

References

1. Feske SK: Ischemic Stroke. *Am J Med* 2021, 134(12):1457–1464. https://doi.org/10.1016/j.amjmed.2021.07.027 PMID: 34454905
2. Syahrul S, Maliga HA, Ilmawan M, Fahriani M, Mamada SS, Fajar JK, et al: Hemorrhagic and ischemic stroke in patients with coronavirus disease 2019: incidence, risk factors, and pathogenesis—a systematic review and meta-analysis. *F1000Res* 2021, 10:34. https://doi.org/10.12688/f1000research.42308.1 PMID: 33708378
3. Li N, Yanjie L, Hewei Q: Research progress in rehabilitation assessment and treatment of dysphagia after strok. *China Medical Herald* 2020, 17(28):5–6.
4. Haixia Q, Lingling Z, Qin Q: Continuous nursing in stroke patients with dysphagia. *Chinese Journal of Advanced Nursing* 2021, 36(24):6–9.
5. Ko N, Lee HH, Sohn MK, Kim DY, Shin YI, Oh GJ, et al: Status Of Dysphagia After Ischemic Stroke: A Korean Nationwide Study. *Arch Phys Med Rehabil* 2021, 102(12):2343–2352 e2343. https://doi.org/10.1016/j.apmr.2021.07.788 PMID: 34348122
6. Smith EE, Kent DM, Bulsara KR, Leung LY, Lichtman JH, Reeves MJ, et al: Effect of Dysphagia Screening Strategies on Clinical Outcomes After Stroke: A Systematic Review for the 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke. *Stroke* 2018, 49(3):e123–e128. https://doi.org/10.1161/STR.0000000000000159 PMID: 29367332
7. Arnold M, Liesirova K, Broeg-Morvay A, Meisterernst J, Schlager M, Mono ML, et al: Dysphagia in Acute Stroke: Incidence, Burden and Impact on Clinical Outcome. *PLoS One* 2016, 11(2):e0148424. https://doi.org/10.1371/journal.pone.0148424 PMID: 26863627
8. Zhang L, Tang X, Wang C, Ding D, Zhu J, Zhou Y, et al: Predictive Model of Dysphagia and Brain Lesion-Symptom Mapping in Acute Ischemic Stroke. *Front Aging Neurosci* 2021, 13:753364. https://doi.org/10.3389/fnagi.2021.753364 PMID: 34744695
9. Shenoy AM, McCune M, AbdelRazek MA: A Multifaceted Approach to Improving Postischemic Stroke Dysphagia Screening at a Community Hospital. *Neurologist* 2021, 26(5):167–169. https://doi.org/10.1097/NRL.0000000000000340 PMID: 34491931
10. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P: Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009, 6(7):e1000097. https://doi.org/10.1371/journal.pmed.1000097 PMID: 19621072
11. Lo CK, Mertz D, Loeb M: Newcastle-Ottawa Scale: comparing reviewers' to authors' assessments. *BMC Med Res Methodol* 2014, 14:45. https://doi.org/10.1186/1471-2288-14-45 PMID: 24690082
12. Hao W, Feng X, Wu X: Analysis of risk factors for dysphagia after ischemic stroke. *Medical Review* 2018, 24(22):4551–4554.
13. Beharry A, Michel P, Faouzi M, Kuntzer T, Schweizer V, Diserens K: Predictive Factors of Swallowing Disorders and Bronchopneumonia in Acute Ischemic Stroke. *J Stroke Cerebrovasc Dis* 2019, 28(8):2148–2154. https://doi.org/10.1016/j.jstrokecerebrovasdis.2019.04.025 PMID: 31129105
14. Cong L, Jiang H: Analysis of risk factors related to swallowing dysfunction after ischemic stroke. *Chinese Journal of Cerebrovascular Diseases* 2012, 9(8):408–411.

15. Flowers HL, AlHarbi MA, Mikulis D, Silver FL, Rochon E, Streiner D, et al: MRI-Based Neuroanatomical Predictors of Dysphagia, Dysarthria, and Aphasia in Patients with First Acute Ischemic Stroke. *Cerebrovasc Dis Extra* 2017, 7(1):21–34. https://doi.org/10.1159/000457810 PMID: 28208139

16. Henke C, Foerch C, Lapa S: Early Screening Parameters for Dysphagia in Acute Ischemic Stroke. *Cerebrovasc Dis* 2017, 44(5–6):285–290. https://doi.org/10.1159/000480123 PMID: 28903096

17. Huang Y, Liang F, Liao H: Analysis of related risk factors for dysphagia after ischemic stroke in 563 cases *Chinese Journal of Epidemiology* 2007, 28(6):601–604.

18. Lapa S, Luger S, Pfeilschifter W, Henke C, Wagner M, Foerch C: Predictors of Dysphagia in Acute Pontine Infarction. *Stroke* 2017, 48(5):1397–1399. https://doi.org/10.1161/STROKEAHA.116.015045 PMID: 28400488

19. Meng C, Xuemei S, Li L: Analysis of the incidence and influencing factors of dysphagia after acute ischemic stroke *Chinese Journal of Nursing* 2021, 36(2):4–7.

20. Remesso GC, Fukujima MM, Chiappetta AL, Oda AL, Aguiar AS, Oliveira Ade S, et al: Swallowing disorders after ischemic stroke. *Arq Neuropsiquiatr* 2011, 69(5):785–789. https://doi.org/10.1590/s0004-282x2011000600012 PMID: 22042182

21. Yang H, Yi Y, Han Y, Kim HJ: Characteristics of Cricopharyngeal Dysphagia After Ischemic Stroke. *Ann Rehabil Med* 2018, 42(2):204–212. https://doi.org/10.5535/arm.2018.42.2.204 PMID: 29765873

22. Lapa S, Foerch C, Singer OC, Hattingen E, Luger S: Ischemic Lesion Location Based on the ASPECT Score for Risk Assessment of Neurogenic Dysphagia. *Dysphagia* 2021, 36(5):882–890. https://doi.org/10.1007/s00455-020-10204-0 PMID: 33159258

23. Gu HQ, Yang X, Wang CJ, Zhao XQ, Wang YL, Liu LP, et al: Clinical Characteristics, Management, and In-Hospital Outcomes in Patients With Stroke or Transient Ischemic Attack in China. *JAMA Netw Open* 2021, 4(8):e2120745. https://doi.org/10.1001/jamanetworkopen.2021.20745 PMID: 34387677

24. Yongjun W, Zixiao L, Hongqiu G: China Stroke Report 2019 *Chinese Journal of Stroke* 2020, 9 (10):1037–1043.

25. Yuan S, Lihua W: Epidemiology and risk factors of stroke in young adults. *Journal of Cardiovascular Rehabilitation Medicine* 2020, 29(4):4–9.

26. Nan T: Field investigation on the current status of rehabilitation intervention for dysphagia after stroke. *Chhinese Journal of Nursing* 2021, 36(20):4–8.

27. Daniels SK, Anderson JA, Willson PC: Valid items for screening dysphagia risk in patients with stroke: a systematic review. *Stroke* 2012, 43(3):892–897. https://doi.org/10.1161/STROKEAHA.111.640946 PMID: 22308250

28. Toscano M, Vigano A, Rea A, Verzina A, Sasso D'Elia T, Puledda F, et al: Sapienza Global Bedside Evaluation of Swallowing after Stroke: the GLOBE-3S study. *Eur J Neurol* 2019, 26(4):596–602. https://doi.org/10.1111/ene.13862 PMID: 30414300

29. Martino R, Silver F, Teasell R, Bayley M, Nicholson G, Streiner DL, et al: The Toronto Bedside Swallowing Screening Test (TOR-BSST): development and validation of a dysphagia screening tool for patients with stroke. *Stroke* 2009, 40(2):555–561. https://doi.org/10.1161/STROKEAHA.107.510370 PMID: 19074483

30. Boaden E, Burnell J, Hives L, Dey P, Clegg A, Lyons MW, et al: Screening for aspiration risk associated with dysphagia in acute stroke. *Cochrane Database Syst Rev* 2021, 10:CD012679. https://doi.org/10.1002/14651858.CD012679.pub2 PMID: 34661279

31. Lee WH, Lim MH, Seo HG, Oh BM, Kim S: Hyoid kinematic features for poor swallowing prognosis in patients with post-stroke dysphagia. *Sci Rep* 2021, 11(1):1471. https://doi.org/10.1038/s41598-020-80871-4 PMID: 33446787

32. Kumar S, Doughty C, Doros G, Selim M, Lahoti S, Gokhale S, et al: Recovery of swallowing after dysphagic stroke: an analysis of prognostic factors. *J Stroke Cerebrovasc Dis* 2014, 23(1):56–62. https://doi.org/10.1016/j.jstrokecerebrovasdis.2012.09.005 PMID: 23102742

33. Barritt AW, Smithard DG: Role of cerebral cortex plasticity in the recovery of swallowing function following dysphagic stroke. *Dysphagia* 2009, 24(1):83–90. https://doi.org/10.1007/s00455-008-9162-3 PMID: 18716838

34. Li S, Luo C, Yu B, Yan B, Gong Q, He C, et al: Functional magnetic resonance imaging study on dysphagia after unilateral hemispheric stroke: a preliminary study. *J Neurol Neurosurg Psychiatry* 2009, 80 (12):1320–1329. https://doi.org/10.1136/jnnp.2009.176214 PMID: 19515639

35. Ickenstein GW, Hohlig C, Prosiegel M, Koch H, Dziewas R, Bodechtel U, et al: Prediction of outcome in neurogenic oropharyngeal dysphagia within 72 hours of acute stroke. *J Stroke Cerebrovasc Dis* 2012, 21(7):569–576. https://doi.org/10.1016/j.jstrokecerebrovasdis.2011.01.004 PMID: 21683618

36. Zhang D, Li Y, Li H, Fu W, Zeng J, Zeng X: Analysis of Factors That Influence the Prognosis of Swallowing Function Rehabilitation Therapy in Patients with Dysphagia After Medullary Infarction. *Neuropsychiatr Dis Treat* 2022, 18:97–107. https://doi.org/10.2147/NDT.S341353 PMID: 35079218

37. Morrison RA, Hays SA, Kilgard MP: Vagus Nerve Stimulation as a Potential Adjuvant to Rehabilitation for Post-stroke Motor Speech Disorders. *Front Neurosci* 2021, 15:715928. https://doi.org/10.3389/fnins.2021.715928 PMID: 34489632

38. Hui C, Yan Z, Chunhua W: Meta-analysis of risk factors for early neurological deterioration in patients with ischemic stroke *Journal of Chengde Medical College* 2019, 36(5):7–11.

39. Matsuo T, Matsuyama M: Detection of poststroke oropharyngeal dysphagia with swallowing screening by ultrasonography. *PLoS One* 2021, 16(3):e0248770. https://doi.org/10.1371/journal.pone.0248770 PMID: 33730038

40. Jones CA, Colletti CM, Ding MC: Post-stroke Dysphagia: Recent Insights and Unanswered Questions. *Curr Neurol Neurosci Rep* 2020, 20(12):61. https://doi.org/10.1007/s11910-020-01081-z PMID: 33136216

41. Choi JS, Bang H, Lee GJ, Seo HG, Oh BM, Han TR: Epiglottic Retroflexion is a Key Indicator of Functional Recovery of Post-stroke Dysphagia. *Ann Rehabil Med* 2020, 44(1):1–10. https://doi.org/10.5535/arm.2020.44.1.1 PMID: 32130834

42. Qiu X, Yao XJ, Han SN, Wu YY, Ou ZJ, Li TS, et al: Acupuncture Reduces the Risk of Dysphagia in Stroke Patients: A Propensity Score-Matched Cohort Study. *Front Neurosci* 2021, 15:791964. https://doi.org/10.3389/fnins.2021.791964 PMID: 35069105

43. Ran Z, Weixin C, Lili D: Meta-analysis of risk factors for dysphagia in patients with ischemic stroke. *Chinese Journal of Stroke* 2022, 16(12):7–9.

44. Huixian F: Analysis of the influencing factors of neurogenic dysphagia after stroke. *China Journal of Practical Neurological Diseases* 2013, 16(21):3–5.

45. Al-Khaled M, Matthis C, Binder A, Mudter J, Schattschneider J, Pulkowski U, et al: Dysphagia in Patients with Acute Ischemic Stroke: Early Dysphagia Screening May Reduce Stroke-Related Pneumonia and Improve Stroke Outcomes. *Cerebrovasc Dis* 2016, 42(1–2):81–89. https://doi.org/10.1159/000445299 PMID: 27074007

46. Won SY, Krieger S, Dubinski D, Gessler F, Behmanesh B, Freiman TM, et al: Neurogenic Dysphagia in Subdural Hematoma. *Front Neurol* 2021, 12:701378. https://doi.org/10.3389/fneur.2021.701378 PMID: 35153966

47. Dziewas R, Michou E, Trapl-Grundschober M, Lal A, Arsava EM, Bath PM, et al: European Stroke Organisation and European Society for Swallowing Disorders guideline for the diagnosis and treatment of post-stroke dysphagia. *Eur Stroke J* 2021, 6(3):LXXXIX–CXV. https://doi.org/10.1177/23969873211039721 PMID: 34746431

48. Sherman V, Greco E, Martino R: The Benefit of Dysphagia Screening in Adult Patients With Stroke: A Meta-Analysis. *J Am Heart Assoc* 2021, 10(12):e018753. https://doi.org/10.1161/JAHA.120.018753 PMID: 34096328

49. Dziewas R, Allescher HD, Aroyo I, Bartolome G, Beilenhoff U, Bohlender J, et al: Diagnosis and treatment of neurogenic dysphagia—S1 guideline of the German Society of Neurology. *Neurol Res Pract* 2021, 3(1):23. https://doi.org/10.1186/s42466-021-00122-3 PMID: 33941289

50. Suntrup-Krueger S, Minnerup J, Muhle P, Claus I, Schroder JB, Marian T, et al: The Effect of Improved Dysphagia Care on Outcome in Patients with Acute Stroke: Trends from 8-Year Data of a Large Stroke Register. *Cerebrovasc Dis* 2018, 45(3–4):101–108. https://doi.org/10.1159/000487811 PMID: 29533960

51. Dallal York J, Leonard K, Anderson A, DiBiase L, Jeng EI, Plowman EK: Discriminant Ability of the 3-Ounce Water Swallow Test to Detect Aspiration in Acute Postoperative Cardiac Surgical Patients. *Dysphagia* 2021. https://doi.org/10.1007/s00455-021-10333-0 PMID: 34268585

52. Umay E, Eyigor S, Ertekin C, Unlu Z, Selcuk B, Bahat G, et al: Best Practice Recommendations for Stroke Patients with Dysphagia: A Delphi-Based Consensus Study of Experts in Turkey-Part I: Management, Diagnosis, and Follow-up. *Dysphagia* 2021.

53. Eltringham SA, Smith CJ, Pownall S, Sage K, Bray B: Variation in Dysphagia Assessment and Management in Acute Stroke: An Interview Study. *Geriatrics (Basel)* 2019, 4(4).

54. Pacheco-Castilho AC, Vanin GM, Dantas RO, Pontes-Neto OM, Martino R: Dysphagia and Associated Pneumonia in Stroke Patients from Brazil: A Systematic Review. *Dysphagia* 2019, 34(4):499–520. https://doi.org/10.1007/s00455-019-10021-0 PMID: 31111249

55. Teuschl Y, Trapl M, Ratajczak P, Matz K, Dachenhausen A, Brainin M: Systematic dysphagia screening and dietary modifications to reduce stroke-associated pneumonia rates in a stroke-unit. *PLoS One* 2018, 13(2):e0192142. https://doi.org/10.1371/journal.pone.0192142 PMID: 29389984

56. Krishnamurthy R, Balasubramanium RK, Premkumar PK: Systematic Review and Meta-Analysis of Dysphagia and Associated Pneumonia in Patients With Stroke From India: A Call to Arms. *Am J Speech Lang Pathol* 2022, 31(1):502–514. https://doi.org/10.1044/2021_AJSLP-21-00175 PMID: 34982940

57. Liu CH, Huo M, Qin HH, Zhao BL: Critical prognostic factors for poststroke dysphagia: a meta-analysis. *Eur Rev Med Pharmacol Sci* 2022, 26(2):610–622. https://doi.org/10.26355/eurrev_202201_27888 PMID: 35113437

58. Ning S: The application value of water drinking test in patients with dysphagia after acute stroke *Chinese Medicine Guide* 2020, 12(3):11–14.

59. Yang H, Zhiyu G, Xuguang G: Analysis of influencing factors on prognosis of patients with acute cerebral stroke. *Chinese Journal of Cardiovascular and Cerebrovascular Diseases in the Aged* 2014, 16 (3):240–242.

60. Jannini TB, Ruggiero M, Vigano A, Comanducci A, Maestrini I, Giuliani G, et al: The role of the Sapienza GLObal Bedside Evaluation of Swallowing after Stroke (GLOBE-3S) in the prevention of stroke-associated pneumonia (SAP). *Neurol Sci* 2022, 43(2):1167–1176. https://doi.org/10.1007/s10072-021-05449-y PMID: 34269936