SM Physical Medicine & Rehabilitation

Research Article



# Incidence rate of pneumonia after post-stroke dysphagia: A meta-analysis

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## Abstract

**Objective:** To figure out the latest incidence rate of pneumonia after post-stroke-dysphagia (PSD), related literature was included, then a meta-analysis was completed.

**Methods:** Articles on the incidence rate of pneumonia after PSD was searched by manual and electrical databases. Data were selective by screening the abstract, browsing the full text according to diagnostic criteria, and extracting the data on incidence rate of pneumonia. Subsequently, a meta-analysis was performed using Stata 16.

**Results:** 1900 studies were initially retrieved and 14 studies met the inclusion criteria for meta-analysis after extraction. The meta-analysis showed that the pooled incidence rate of pneumonia was 39% and the overall effect was 11.046 with high heterogeneity ($I^2$>75%) using random effects. Furthermore, the incidence rate of pneumonia in the dysphagia group was 4.39 times higher than in the non-dysphagia group, with medium heterogeneity $I^2$=60.5%. To find the heterogeneity, a subgroup analysis was carried out and the results indicated that the incidence rate of pneumonia was 37% in the prospective group and 26% in the retrospective group, but all with high heterogeneity ($I^2$>75%). Finally, the combined incidence rate of hospital-acquired pneumonia was 0.26 without heterogeneity, which could be associated with sources and types of literature.

**Conclusion:** Our results have analyzed the incidence rate of pneumonia after PSD in 14 related literature, and the results showed that there was a 39% incidence rate of pneumonia in PSD patients, which might have certain guiding significance for early treatment and prognosis of pneumonia.

**Keywords**: Pneumonia; Dysphagia; Stroke; Incidence Rate; Meta analysis

## Introduction

Stroke is one of the most common neurogenic diseases characterized by loss of neurological function caused by hemorrhage or ischemia in brain tissue. Among them, swallowing dysfunction was the most common complication after stroke, defined as post-stroke-dysphagia (PSD)[1]. According to statistics, up to 80% of stroke patients encounter dysphagia [2], the incidence rate is associated with early dysphagia screening, therapies, and postural control management, etc.[3]. For the other complications after stroke, malnutrition and dehydration are also common, especially pneumonia attributed to aspiration [4]. Research showed that there were 4% to 10% of patients who had pneumonia after stroke, which was related to dysphagia with a high mortality rate.

**Submitted:** 02 November 2023 | **Accepted:** 27 November 2023 | **Published:** 30 November 2023

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**Citation:** Yea Q, Hub J, Daib Y, Qiaoa J, Doua Z (2023) Incidence rate of pneumonia after post-stroke dysphagia: A meta-analysis. SM Phys Med Rehabil 4: 9.

Pneumonia is one of the most common complication after stroke, ranging from 5% to 22%[5,6], which may affect the mortality in stroke patients, reaching 3.06 times independently associated. Pneumonia is closely associated with aspiration, and the presence of tracheal intubation after stroke is also an important factor for pneumonia, although it avoids a certain amount of food aspiration [7]. Regarding the cause of pneumonia, the decline in the immune system after stroke could increase the incidence rate of infection. Furthermore, the response of tracheal epithelial cells caused by the immunomodulatory response after stroke will altered, resulting in a reduction in lung clearance and an increase in the appearance of aspiration[5]. In fact, the severity of pneumonia was closely related to the severity of stroke, age, and consciousness [8]. Pneumonia after PSD is the main cause of death in stroke, associated with early assessment, age, complications, or more severe neurological impairment.

Pneumonia after stroke can influence the severe rate and mortality during hospital stay, which also increases the medical and economic burden to the country. Among those, dysphagia was a risk factor for pneumonia after stroke. As previous studies reported, the nasogastric tubes were associated with respiratory infections, and the diagnostic criteria was also closely related to the occurrence of pneumonia in clinical stroke [9]. Thus, the reported incidence rate of pneumonia after stroke in the literature was highly variable due to a variety of factors, of which dysphagia was a contributing factor. However, there was no existing statistical data showing the incidence rate of pneumonia after PSD recently. In our study, literature related to pneumonia after PSD was searched from the electrical databases, then a meta-analysis was performed to view the incidence rate of pneumonia after PSD. It would provide theoretical and data guidance for clinicians on reducing the incidence rate of pneumonia after PSD.

## Methods

The method for this meta-analysis was guided by the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement for systematic reviews [10] The study protocol was registered on PROSPERO (an international prospective registry of systematic reviews) with the registration number CRD42023390385.

The PICOS framework was used to formulate the study protocol. Population: All patients diagnosed with dysphagia after stroke. Outcome: The incidence rate of pneumonia after PSD was the primary outcome measure. The type of study was limited to cohort study. This review did not have an intervention. Partial research has been grouped into the control group without dysphagia.

### Study eligibility

*Inclusion criteria* The studies included met the following criteria: Cohort study; the subjects were human; the retrieval time was conducted from the beginning of the database to September 24, 2023; Age>18; definite diagnosis of stroke; patients diagnosed with swallowing disorder through Videofluoroscopic Swallowing Study (VFSS), Flexible Endoscopic Evaluation Swallowing (FEES), or other evaluation methods, not limited to Standard Swallowing Assessment (SSA); patients diagnosed with pneumonia (clinical symptoms and signs, chest X-ray or CT inspection); contained complete data of incidence rate.

*Exclusion criteria* Patients without dysphagia after diagnosis of VFSS or FEES; patients with leakage or aspiration and without inflammatory infiltration with chest X-ray; review article; meta-analysis article.

### Data sources

The academic databases used for the systematic review included Web of Science, Embase, China National Knowledge Infrastructure (CNKI), China Biomedical Literature Database (CBM), Wanfang database, China Science and Technology Journal Database (cqvip) and PubMed. Keywords related to the population and outcome used synonyms for each disease according to the respective medical subject headings (MeSH). The search strategy was as follows. Web of Science: TS=(pneumonia* OR pulmonary infection) AND TS=(cerebral apoplexy* OR cerebrovascular accident OR stroke) AND TS=(dysphagia) AND TS=(incidence); Embase: ('stroke'/exp OR 'cerebrovascular accident'/exp OR 'cerebral apoplexy'/exp) AND ('aspiration pneumonia'/exp OR 'pneumonia'/exp) AND ('dysphagia'/exp OR 'swallowing disorder'/exp OR 'swallowing dysfunction'/exp) AND ('incidence'/exp); Pubmed: (stroke or cerebral apoplexy or cerebrovascular accident) and (dysphagia or swallowing disorder) and (pneumonia or aspiration pneumonia or pulmonary infection) and incidence; CNKI: (SU= swallowing disorder OR SU= dysphagia) AND (SU= stroke OR SU= cerebral apoplexy OR= cerebrovascular accident) AND (SU= pneumonia OR SU= pulmonary infection) AND (SU= incidence); The search strategy of Wanfang database, cqvip and CBM were similar to CNKI with respective medical subject headings.

### Study selection

The literature was screened in the following logical three-stage: title and abstract screening, full text screening, and extraction. Two authors (Qiuping Ye and Jiahui Hu) independently screened the retrieved studies. When the full text was not immediately available, it would be obtained through correspondence with the authors. No additions were requested other than those contained in published manuscripts

### Data extraction

Data extraction was carried out in parallel by two reviewers (Qiuping Ye and Jiahui Hu). The study details (author, year of publication), study characteristics (design, setting) and participant data (population size, male/female ratio, mean age at diagnosis, incidence rate for diseases and the corresponding data of amount) were extracted. The data extraction process was shown in Figure 1. Conflicts in the process of study selection could be discussed and determined by the third author (Yong Dai).

### Risk of bias assessment

The heterogeneity assessment was performed using the $I^2$ statistic. $I^2$ <50% was thought to represent low heterogeneity, $I^2$ >50% was thought to represent moderate heterogeneity, and $I^2$ >75% represented high heterogeneity. Publication bias within the studies was evaluated with a funnel plot using a random effects model.

The quality of the included studies was evaluated using the Newcastle-Ottawa Scale [11] that was adapted to fit this review. They were assessed using the following terms: selection (representative of the exposure cohort, determination of exposure, definition of controls, and whether the study population is large enough), comparability (comparability of cases and controls on the basis of the design or analysis). The maximum score of available points was five.

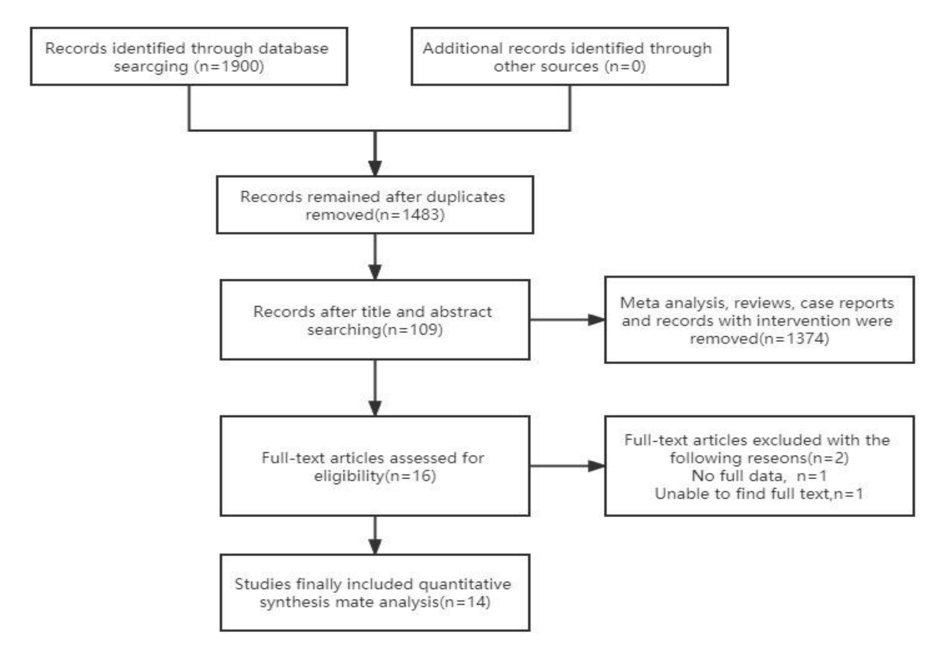


**Figure 1** PRISMA flow diagram for study screening and selection for Meta-analysis of pneumonia after PSD was showed.

## Data synthesis

The distribution of the incidence rate and the 95% confidence intervals obtained from the studies were examined using a forest plot. A random effects model was used to pool the incidence rate among these data. Subgroup analysis was used to explore the effect of different types of study, including the prospective study or retrospective study, and the incidence rate of hospital-acquired pneumonia or follow-up acquired pneumonia. The meta-analysis was performed using Stata 16.

## Results

The study selection process was shown in a PRISMA flow diagram in Figure 1. 1900 studies were retrieved according to the initial search strategy. 417 studies were excluded after repeated checking and 1482 studies remained for the next-stage screening. After selecting the title and abstract, meta-analysis, review, case report, and studies that included intervention were removed, including 1374 studies, leaving 109 studies for the full text screening.

Following the full text screening, 93 studies without dysphagia were excluded, two studies had incomplete data. Finally, 14 studies met the inclusion criteria for the meta-analysis. Table 1 provided an overview of the characteristics of the 14 studies. And the quality of the included studies was shown in Table 2. There were two articles with four asterisks (*) and four had three asterisks (*), which might have relatively high quality, while others had only two asterisks (*) with probably low quality.

Among the 14 studies, hospital-acquired pneumonia was reported as the result in 3 studies [12], while the others were pneumonia. The follow-up acquired pneumonia was shown to be the outcome in two studies [13,14]. Furthermore, 6 studies [15] were the perspective study and 8 studies [16] were the retrospective study, among which the incidence rate of pneumonia after PSD was compared with that of non-dysphagia in 7 studies.

The total meta-analysis for the incidence rate of pneumonia was shown in the forest plot in Figure 2. The random effects meta-analysis demonstrated that the pooled incidence rate of pneumonia was 39% (95%CI 0.25-0.36) (Figure 2). The overall effect was 11.046 with high heterogeneity ($I^2$ =95.7%). From the confidence intervals, we might speculate that the percentage of variation between studies was due to heterogeneity rather than chance. Combined with the funnel plot that distributed asymmetry (Figure 6), the existence of publication bias was indicated.

For comparison of the incidence rate between the dysphagia group and the non-dysphagia group, the meta-analysis with 7 results was carried out. And the incidence rate of pneumonia in the dysphagia group was 4.39 times higher than in the non-dysphagia group, with medium heterogeneity $I^2$=60.5% (Figure 3).

To figure out the reason for high heterogeneity among the meta-analysis, a subgroup analysis was then performed according to the types of study (prospective study or retrospective study). The pooled results in the prospective study showed that the incidence rate of pneumonia was 37% (95% CI 0.22-0.52) with high heterogeneity ($I^2$ =94.3%) (Figure 4a). The overall effect was 5.622. For the retrospective study, the pooled incidence rate of pneumonia was 26% (95% CI 0.20-0.32) with a general effect of

**Table 1:** The characteristics in the 14 studies.

| Study | Year | Male/ Female | Age | Evaluation method of swallowing | Types of stroke | Medical-history | Incidence in groups |
|---|---|---|---|---|---|---|---|
| Zhao | 2013 | 104/44 | 67~83 | Kubota drinking water | TACI and PACI/ POCI | Not mentioned | 56/148 |
| Ho | 2018 | 2921/ 2111 | 18~80 | VFSS/ FEES | Not mentioned | HTN/CAD/ cardiac dysrhythmia/ hyperlipidemia/ valvular heart disease/ renal disease/ diabetes and COPD | 945/5032 |
| Matsumura | 2014 | 29/47 | 74.7± 8.4 | Fujima Ichiro swallowing efficacy evaluation criteria | Ischemia/ cerebral hemorrhage | Vascular impairment/ Respiratory disease/ diabetes/ Hypertension/ heart disease | 10/76 |
| Wang | 2013 | 75/52 | 65~95 | SSA | Ischemia/ cerebral hemorrhage | Diabetes/Hypertension/atrial fibrillation/smokers drinking | D, 21/70 N-D,5/57 |
| Jin | 2001 | 69/21 | 36~96 | Kubota drinking water | Ischemia/ cerebral hemorrhage | Not mentioned | D,17/34 N-D,7/56 |
| Masiero | 2008 | 32/35 | 72.9± 12.2 | FEES | Ischemia/ cerebral hemorrhage | Diabetes/ Hypertension/ COPD/ smokers | 9/67 |
| Pan | 2008 | 120/72 | 36~84 | Kubota drinking water | Ischemia/ cerebral hemorrhage | Hypertension/ coronary disease/ hyperlipidemia | D,22/56 N-D,8/136 |
| Chen | 2009 | 123/95 | 32~81 | Kubota drinking water | Ischemia/ cerebral hemorrhage | Not mentioned | D,28/81 N-D, 10/137 |
| Jiao | 2007 | 277/ 103 | 43~82 | Kubota drinking water | Ischemia/ cerebral hemorrhage/ subarachnoid hemorrhage | Not mentioned | D,52/196 N-D, 19/184 |
| Wang | 2006 | 191/ 155 | 36~90 | Kubota drinking water | Ischemia/ cerebral hemorrhage/ subarachnoid hemorrhage | Not mentioned | D,43/183 N-D,8/173 |
| Zhang | 2012 | 39/16 | 45~90 | MMASA | Ischemia/ cerebral hemorrhage | Hypertension/ coronary disease/ stroke/ Heart disease/ smoking/drinking | 30/55 |
| Brogan | 2014 | 292/241 | 71± 14.9 | clinical bedside evaluation of Swallowing | Not mentioned | Not mentioned | 52/312 |
| Al-Khaled | 2016 | 1336/ 1747 | 76± 12 | dysphagia screening | Not mentioned | Diabetes/ Hypertension/ Hypercholesterolemia/ Atrial fibrillation | 917/3083 |
| Wang | 2012 | Not mentioned | ≦85 | SSA | Not mentioned | Not mentioned | D,36/184 N-D, 17/187 |

Totalanteriorcirculationinfarcts,TACI; Partialanteriorcirculationinfarcts, PACI Posteriorcirculationinfarcts, POCI; Modified Mann assessment of swallowing ability, MMASA; Hypertension, HTN, Coronary artery disease, CAD; Chronic obstructive pulmonary disease, COPD; Standardized swallowing assessment, SSA; Dysphagia, D; Non-Dysphagia, N-D

**Table 2:** The quality of included studies.

| Evaluation projects Studies | Representativeness | | | | Comparability | Results | | |
|---|---|---|---|---|---|---|---|---|
| | Representative of the exposure cohort | Whether the study population is large enough | Ascertainment of exposure | Demonstration that outcome of interest was not present at start of study | Comparability of cohorts on the basis of the design or analysis | Result assessment | Is the follow-up time long enough | Adedance of cohort follow-up |
| Zhao 2013 | * | | | | * | | | |
| Ho 2018 | * | | | | * | | | |
| Matsumura 2014 | * | | | | * | | | |
| Wang 2013 | * | | | | * | | | |
| Jin 2001 | * | | | | * | | | |
| Masiero 2008 | * | | | | * | | * | * |
| Pan 2008 | * | | | | | | | |
| Chen 2009 | * | | | | * | | | |
| Jiao 2007 | * | | | | * | | | |
| Wang 2006 | * | | | | | | | |
| Zhang 2012 | * | | | | * | | | |
| Brogan 2014 | * | | | | * | | * | * |
| Al-Khaled 2016 | * | | | | * | | * | |
| Wang 2012 | * | | | | * | | * | |

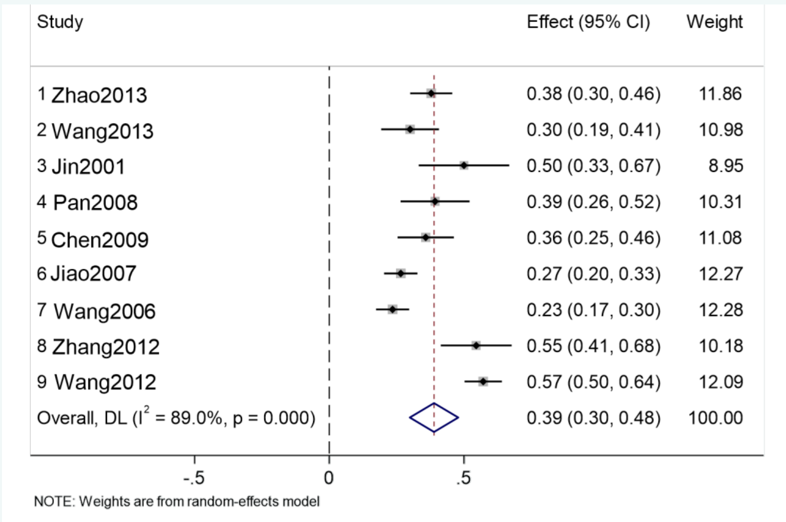


**Figure 2** Forest plot for the pooled meta analysis of the incidence rate of pneumonia after PSD, with 95% confidence intervals.

8.01 (Figure 4b). However, the heterogeneity was high both in the prospective study and in the retrospective study.

Furthermore, the combined incidence rate of hospital acquired pneumonia was 0.26 (95% CI 0.22-0.30) without heterogeneity ($I^2$=0) (Figure 5), which could indicate that the type of pneumonia is also a source of heterogeneity.

## Discussion

The main finding of our study indicated that the incidence rate of pneumonia after PSD was 39% (95% CI 0.3, 0.48). Importantly, the incidence rate of pneumonia in the dysphagia group was 4.39 times higher than that in the non-dysphagia group, indicating that dysphagia was an important factor influencing pneumonia. Furthermore, the incidence rate for the prospective study was 35% (95% CI 0.23, 0.48), while there was 26% (95% CI 0.20, 0.32) in the retrospective study.

However, there was high heterogeneity in the pooled meta-analysis, so were the subgroup meta-analysis in the prospective

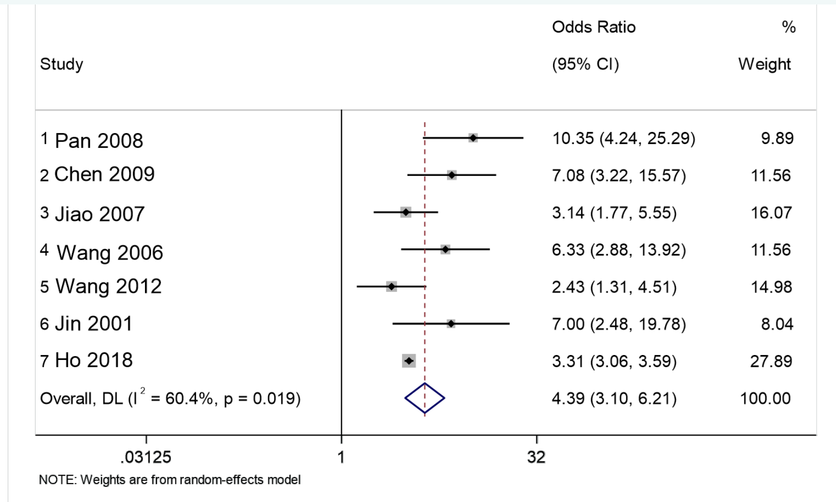


**Figure 3** Forest plot for the pooled meta analysis of the incidence rate of pneumonia between dysphagia group and non-dysphagia group, with 95% confidence intervals.

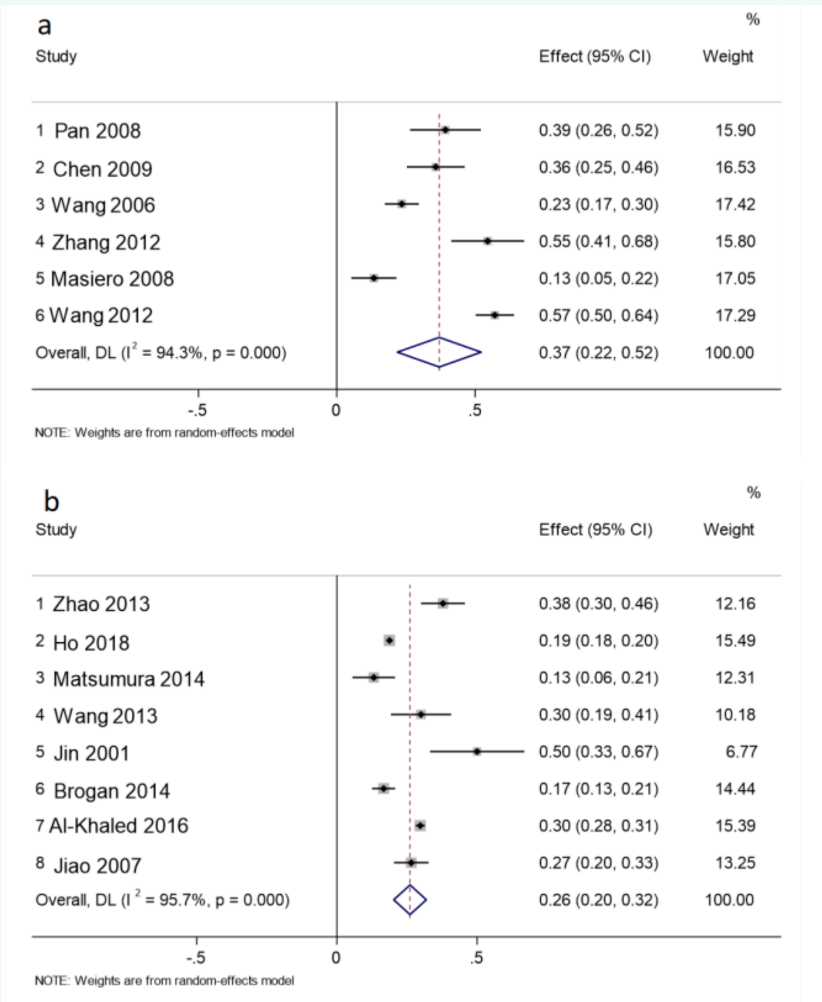


**Figure 4** Forest plot for the meta analysis of the incidence rate for pneumonia after PSD in prospective study (a) and retrospective study(b), with 95% confidence intervals.

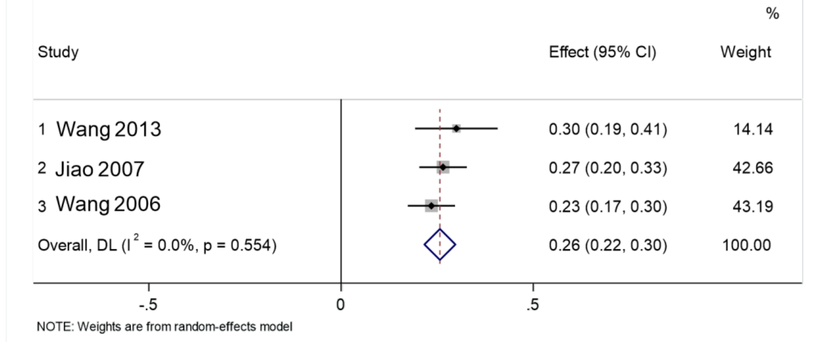


**Figure 5** Forest plot for the meta analysis of the incidence rate for pneumonia after PSD in hospital acquired pneumonia, with 95% confidence intervals.

or retrospective studies. To explore the reasons for the above results, it was suggested that the sources of these studies were different, regardless of the different methods of dysphagia evaluation or the types of study. After subgroup analysis, the heterogeneity in the subgroups remained high, indicating that the grouping of study types could not reduce the heterogeneity. Thus, the heterogeneity of the pooled meta-analysis was due to the different experiences of clinicians in evaluating dysphagia in the articles, the different places or hospitals from which patients come, the various sample sizes, etc. The funnel plot also indicated the publication bias of the included articles (Figure 6). However, there was no heterogeneity in the aggregate outcomes of hospital-acquired pneumonia, indicating that uncertainty after discharge may be another factor contributing to the high heterogeneity of these outcomes.

Furthermore, the incidence rate of pneumonia was compared between patients with and without dysphagia, with medium heterogeneity (Figure 3). In fact, dysphagia was a risk factor for pneumonia, as shown in a previous study[17], but dysphagia was also influenced by early screening or management of swallowing. A retrospective study[18] explored the risk factor of aspiration pneumonia by observing the incidence rate of aspiration pneumonia in 1 year, 3 years, and 5 years, respectively, in the dysphagia and non-dysphagia groups. The results showed that the incidence rate of pneumonia ranged from 24.8% to 58.8% in the dysphagia group, while it occurred from 5.8% to 43.9% in the non-dysphagia group. Dysphagia has been considered to lead to aspiration, and about a third of these can lead to pneumonia [19]. Therefore, another article on acute ischemic stroke also confirmed dysphagia as a risk factor for pneumonia[20]. Additionally, subject to an invasive procedure, being bedridden or having a massive cerebral infarction were other risk factors for pneumonia in that investigation. Actually, old age and other concurrent diseases, such as diabetes and hypertension, were also risk factors for pneumonia[21]. In clinical practice, dysphagia needs multidisciplinary treatment, including swallowing treatment, adjustment of bolus types, oral nursing,

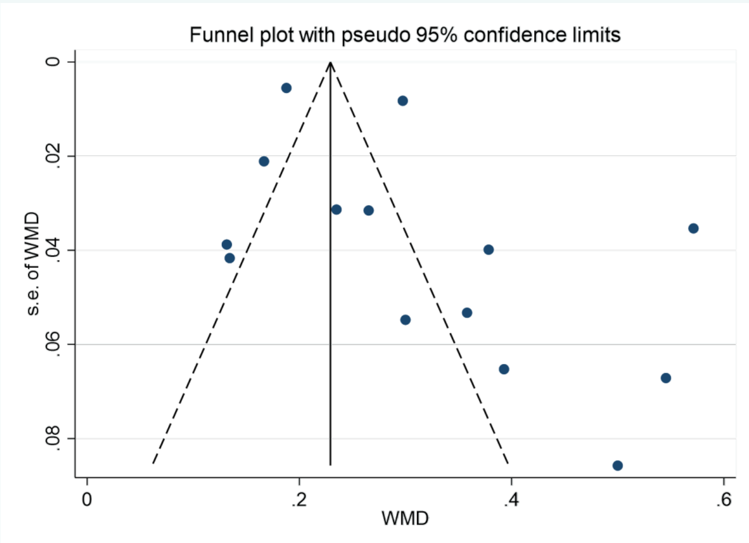


**Figure 6** Begg' s funnel plot of the studies investigating the incidence rate of pneumonia after PSD included in the meta-analysis.

etc. Therefore, the reduction in the incidence rate of pneumonia is also influenced by these factors. In fact, the literature [2] has indicated that dysphagia was experienced in 91.7% of patients with community-acquired pneumonia, suggesting that dysphagia and pneumonia were interrelated factors.

In consideration of the influence of pneumonia in PSD patients, various treatments were used to reduce the incidence rate of pneumonia, including acupuncture[22], mirror therapy[23] and consistency of food[24,25]. Those thicker foods could decrease the risk of aspiration in the process of swallowing. Furthermore, clearing bacteria in oral was another method to reduce aspiration[26]. Although prophylactic antibiotics have been demonstrated to decrease infections in stroke patients, it had no effect on the mortality of pneumonia[27]. Our study summarized the latest incidence rate of pneumonia in patients with PSD and will guide the development of clinical measures that reduced the incidence rate of pneumonia and adjusted the treatment program in time.

### Strengths and limitations

This is the first meta-analysis for the incidence rate of pneumonia in PSD patients. Although dysphagia was a risk factor for the incidence rate of pneumonia, no study had concentrated on the incidence rate of pneumonia after PSD recently. The incidence rate of pneumonia after stroke ranged from 5% to 22%[5,6], but the incidence rate of pneumonia after PSD reached 39% in our analysis, which illustrated the negative effect of dysphagia on the incidence of pneumonia.

Our study has pooled studies on patients with pneumonia after PSD and conducted a meta-analysis on the incidence rate of pneumonia in PSD. But these types of study included prospective study and retrospective study, which might affect the homogeneity of the pooled meta-analysis. Additionally, those studies came from different countries, which could have a different patient populations, medical level and nursing level, even different diagnostic criteria for pneumonia, leading to heterogeneity in the final meta-analysis, as shown in Figure 6. Furthermore, the quality of the included literature was not high and there were very few studies focusing on these epidemiological data. And no recent studies were included, which was another limitation of our study.

## Conclusions

Our results have analyzed the incidence rate of pneumonia after PSD in 14 related articles and the results showed that the incidence rate of pneumonia after PSD reached 39%. Pneumonia is a risk factor for the mortality in stroke patients, reducing its incidence rate is an important work for clinical worker. In this meta-analysis, we have summarized the incidence rate of pneumonia after PSD, which might have some guiding significance for early treatment and prognosis.

### Statement of Ethics

*"An ethics statement is not applicable because this study is based exclusively on published literature."*

### Conflict of Interest Statement

The authors declare that they have no competing interests. No competing financial or non-financial interest from the funders exist.

### Funding Statement

This study is supported by grants from the Youth Program of the National Natural Science Foundation of China (82202807, to Qiuping Ye), and the National Natural Science Foundation of China (81802236, to Zulin Dou).

### Author contributions

Zulin Dou and Qiuping Ye put forward the ideas and designed this article. Qiuping Ye, Jiahui Hu and Yong Dai screened and extracted the data. Qiuping Ye analyzed the data. Qiuping Ye and Jiahui Hu wrote the manuscript. Critical revision of the manuscript was done by Jia Qiao and Zulin Dou.

### Data Availability Statement

The data that support the findings of this study are openly available in http://pubmed.ncbi.nlm.nih.gov.

## References

1. Carnaby, G., Hankey, G. J. & Pizzi, J. Behavioural intervention for dysphagia in acute stroke: a randomised controlled trial. *Lancet Neurol*. (2006), **5**: 31-37.
2. Takizawa, C., Gemmell, E., Kenworthy, J. & Speyer, R. A Systematic Review of the Prevalence of Oropharyngeal Dysphagia in Stroke, Parkinson's Disease, Alzheimer's Disease, Head Injury, and Pneumonia. *Dysphagia*. (2016), **31**: 434-441.
3. Park, K. D., Kim, T. H. & Lee, S. H. The Gugging Swallowing Screen in dysphagia screening for patients with stroke: A systematic review. *Int J Nurs Stud*. (2020), **107**: 103588.
4. Palli, C. *et al.* Early Dysphagia Screening by Trained Nurses Reduces Pneumonia Rate in Stroke Patients: A Clinical Intervention Study. *Stroke*. (2017), **48**: 2583-2585.
5. Dziewas, R. *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**: LXXXIX-CXV.
6. Finlayson O, K. M., Hall R, et al. Risk factors, inpatient care, and outcomes of pneumonia after ischemic stroke. *Neurology*. (2011), **77**: 1338–1345.
7. Katzan IL, C. R., Husak SH, et al. The effect of pneumonia on mortality among patients hospitalized for acute stroke. *Neurology*. (2003), **60**: 620-625.
8. Lioutas, V. A. *et al.* Endotracheal Intubation and In-Hospital Mortality after Intracerebral Hemorrhage. *Cerebrovasc Dis*. (2018), **45**: 270-278.
9. Kim, B. R. *et al.* Risk Factors and Functional Impact of Medical Complications in Stroke. *Ann Rehabil Med*. (2017), **41**: 753-760.
10. Kishore, A. K. *et al.* How is pneumonia diagnosed in clinical stroke

research? A systematic review and meta-analysis. *Stroke*. (2015), **46**: 1202-1209.

11. Brogan, E., Langdon, C., Brookes, K., Budgeon, C. & Blacker, D. Dysphagia and factors associated with respiratory infections in the first week post stroke. *Neuroepidemiology*. (2014), **43**: 140-144.

12. Liberati, A. *et al.* The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ*. (2009), **339**: b2700.

13. Wells GA, S. B., O'Connell DA, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. (2000).

14. Jin YM, L. G. Analysis and nursing of pulmonary infection in stroke patients. *Prevention and Treatment of Cardio-Cerebral-Vascular Disease*. (2001), **1**: 43-44.

15. Jiao HY, G. C., Ma JB, et al. Correlation of post-stroke swallowing disorders and hospital-acquired pneumonia. *Nervous Diseases and Mental Health*. (2007), **7**: 298-299.

16. Wang XM, Z. Y., Zhan C, et al. Clinical analysis of 196 patients with dysphagia after stroke. *Chinese Journal of Practical Nervous Diseases*. (2012), **15**: 19.

17. Masiero S, P. R., Previato C, et al. Pneumonia in stroke patients with oropharyngeal dysphagia: a six-month follow-up study. *Neurological sciences*. (2008), **29**: 139-145.

18. LY, W. Analysis of risk factors and clinical characteristics of swallowing disorders after stroke in elderly patients. *Chinese Journal of Practical Nervous Diseases*. (2013), **16**: 22-23.

19. Pan CH, C. Y., Wang XN, et al. Clinical analysis of swallowing disorders and pneumonia after stroke. *Clinical Medical Engineering*. (2008), **15**: 4-6.

20. Chen XJ, Y. C. Exploring the relationship between swallowing disorder and pneumonia after stroke. *China's community physicians*. (2009), **13**: 10.

21. Zhang XY, R. F., He YK. Early risk factors for pneumonia in acute stroke patients with swallowing disorders: a prospective case series study. *International Journal of Cerebrovascular Diseases*. (2012), **20**: 408-412.

22. Zhao SF, D. Z., He H, et al. Analysis of risk factors for associated pneumonia in patients with swallowing disorders after stroke. *Chinese Journal of Rehabilitation*. (2013), **28**: 439-442.

23. Ho, C. H., Lin, W. C., Hsu, Y. F., Lee, I. H. & Hung, Y. C. One-Year Risk of Pneumonia and Mortality in Patients with Poststroke Dysphagia: A Nationwide Population-Based Study. *J Stroke Cerebrovasc Dis*. (2018), **27**: 1311-1317.

24. Matsumura T, M. Y., Oki Y, et al. Risk factors for the onset of aspiration pneumonia among stroke patients in the recovery stage. *Nihon Ronen Igakkai Zasshi*. (2014), **51**: 364-368.

25. Wang WP, L. B., Zhang M, et al. The relationship between post-stroke swallowing disorders and hospital-acquired pneumonia. *Chin JNosocomio1*. (2006), **16**: 1246-1247.

26. Brogan, E., Langdon, C., Brookes, K., Budgeon, C. & Blacker, D. Respiratory infections in acute stroke: nasogastric tubes and immobility are stronger predictors than dysphagia. *Dysphagia*. (2014), **29**: 340-345.

27. Al-Khaled, M. *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**: 81-89.

28. Eltringham, S. A. *et al.* Impact of Dysphagia Assessment and Management on Risk of Stroke-Associated Pneumonia: A Systematic Review. *Cerebrovasc Dis*. (2018), **46**: 99-107.

29. Feng, M. C. *et al.* The Mortality and the Risk of Aspiration Pneumonia Related with Dysphagia in Stroke Patients. *J Stroke Cerebrovasc Dis*. (2019), **28**: 1381-1387.

30. Harms, H. *et al.* Preventive antibacterial therapy in acute ischemic stroke: a randomized controlled trial. *PLoS One*. (2008), **3**: e2158.

31. Yuan, M. *et al.* Risk factors for and impact of poststroke pneumonia in patients with acute ischemic stroke. *Medicine (Baltimore)*. (2021), **100**: e25213.

32. Aslanyan S, W. C., Diener H-C, et al. Pneumonia and urinary tract infection after acute ischaemic stroke: a tertiary analysis of the GAIN International trial. *Eur J Neurol*. (2004), **11**: 49–53.

33. Cai H, M. B., Gao X, Gao H. Tongue acupuncture in treatment of post-stroke dysphagia. *Int J Clin Exp Med.* (2015), **8**: 14090-14094.

34. He, K. *et al.* Efficacy and Safety of Mirror Therapy for Post-stroke Dysphagia: A Systematic Review and Meta-Analysis. *Front Neurol*. (2022), **13**: 874994.

35. Xiong SL, Z. C., Liu YY, et al. Effect of thickeners on the occurrence of pneumonia and the risk of malnutrition in poststroke swallowing disorders. *Henan Medical Research*. (2021), **30**: 6367.

36. Wu XC, T. N. Effect of food thickener on the incidence rate of pneumonia in patients with swallowing disorders after stroke. *Clinical Medicine*. (2018), **27**: 039.

37. Gosney, M., Martin, M. V. & Wright, A. E. The role of selective decontamination of the digestive tract in acute stroke. *Age Ageing*. (2006), **35**: 42-47.

38. Westendorp W, V. J., Vermeij F, et al. Antibiotic therapy for preventing infections in patients with acute stroke. *Cochrane Database Syst Rev*. (2012), **1**: CD008530.