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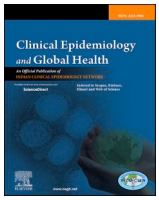

Review article

Aspiration pneumonia among stroke patients in Ethiopia: Systematic review and meta-analysis

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ABSTRACT

Introduction: One of the main complications for stroke patients is aspiration pneumonia, which is an acute lung infection brought on by the entry of endogenous flora and various bodily substances from the gastrointestinal tract into the respiratory system. Aspiration pneumonia following a stroke was linked to older age, gender, dysarthria, denture use, cerebral atrophy, and basal ganglia-infarcted foci. Despite improvements in care, the epidemiological and prognostic effects of pneumonia associated with stroke are increasing mortality and morbidity.

Objective: To assess the pooled prevalence of aspiration pneumonia among stroke patients in Ethiopia.

Methods: Several databases, including PubMed/MEDLINE, EMBASE, Scopus, Google Scholar, African Journals Online (AJOL), grey literature, and articles from the repository of Ethiopian universities, were examined to find available articles. The data were extracted and sorted in Microsoft Excel and exported to STATA/MP 17.0 for analysis. The Newcastle-Ottawa (NOS) was employed to assess each study's qualities. A weighted inverse variance random-effects model with a 95 % confidence interval was used to examine the pooled prevalence of aspiration pneumonia. The Galbraith plot and funnel plot were used to evaluate heterogeneity and publication bias, respectively. To identify the possible cause of heterogeneity, subgroup analysis and meta-regression were performed. P-values less than 0.05 were considered statistically significant.

Result: The pooled prevalence of aspiration pneumonia among stroke patients in Ethiopia was 31.65 % (95 % CI: 25.30–38.01). Visual examination of the Galbraith plot reveals the presence of significant heterogeneity (I^2 = 96.55 %, $p < 0.001$). Studies conducted in Addis Ababa and Harar revealed the highest prevalence of aspiration pneumonia: 37.67 % (95 % CI: 31.56, 43.78). Similarly, articles carried out before 2020 and studies done using cross-sectional study design revealed the highest proportion of aspiration pneumonia: 32.97 % (95 % CI: 24.96, 40.98) and 36.75 (95 % CI: 32.11, 41.38), respectively.

Conclusion: Nearly one-third of stroke patients developed aspiration pneumonia. The highest prevalence was reported in Addis Ababa and Harar regions. As a result, early detection, treatment, and control of stroke are advisable to prevent the occurrence of aspiration pneumonia.

1. Introduction

Stroke is an acute, focal neurological impairment caused by vascular injury (hemorrhage or infarction) to the central nervous system. It ranks as the second most common cause of mortality and disability globally.[1] Every year, fifteen million strokes occur globally, resulting in five million deaths and an extra five million people who are permanently incapacitated. Every year, over 780,000 Americans have a new or recurrent stroke. After heart disease and cancer, stroke mortality is the third-most common cause of death in the United States. Aspiration pneumonia is the medical consequence that results after a stroke that has the highest attributable mortality.[2] The global incidence of aspiration pneumonia among stroke patients was 14 %. Its incidence in Africa is 12 % (Nigeria)[3] and 44 % (Egypt).[4] Especially in individuals with an inadequate cough reflex, aspiration is frequently the result of poor swallowing, which permits oral and stomach contents to reach the lung. Saliva, nasopharyngeal secretions, microorganisms, liquids, poisonous compounds, food, or gastric contents are among the several materials

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that can be aspirated.[5] The natural defenses of the respiratory system are suppressed when gastrointestinal contents enter the lungs, leading to a variety of pulmonary diseases like aspiration pneumonia and acute respiratory distress syndrome, which dramatically raise the morbidity and death rate of stroke patients.[6] Among different aspirations, food aspiration is common in debilitated patients, such as patients with stroke, and leads to a high risk of aspiration pneumonia.[7] One of the main complications for stroke patients is aspiration pneumonia, which is an acute lung infection brought on by the inhalation or entry of endogenous flora and various bodily substances from the gastrointestinal tract into the respiratory system.[8,9] A study showed that 59 % of stroke patients died due to the development of aspiration pneumonia, compared to 8 % of stroke patients who died without aspiration pneumonia.[10] Aspiration pneumonia following a stroke was linked to older age, gender, dysarthria, denture use, cerebral atrophy, and basal ganglia-infarcted foci.[11] It was also significantly associated with increased overall length of stay, poorer functional outcomes poststroke, and a high risk of mortality.[12] Moreover, despite improvements in care, the epidemiological and prognostic effects of pneumonia associated with stroke are increasing mortality, morbidity, length of stay, and hospital costs. To lower the rates of mortality and morbidity in stroke patients, researchers advise early detection of aspiration pneumonia.

Studies conducted in several nations revealed regional variations in the prevalence of aspiration pneumonia. Ethiopia conducted a few research to illustrate the prevalence of aspiration pneumonia. The findings demonstrated a correlation between aspiration pneumonia and elderly individuals, smokers, patients with comorbidities, difficulty swallowing, and epileptic patients. However, there hasn't been any research done in Ethiopia on the cumulative prevalence of aspiration pneumonia in post-stroke patients. Therefore, by analyzing several single studies carried out in various parts of the country, the results of this systematic review and meta-analysis will present an overall picture of national data about aspiration pneumonia among stroke patients in Ethiopia. Therefore, this systematic review and meta-analysis is aimed to assess the pooled prevalence of aspiration pneumonia among stroke patients in Ethiopia.

2. Method

2.1. Reporting and registration protocol

A systematic review and meta-analysis were conducted to estimate the pooled prevalence of aspiration pneumonia among stroke patients. The protocol for this manuscript was not registered into the PROSPERO database. The Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) reporting guideline (Table S1) was used to report the findings of this systematic review and meta-analysis.

2.2. Databases and search strategy

Several databases were examined, such as the African Journals Online (AJOL) repository, EMBASE, Scopus, Google Scholar, PubMed/MEDLINE, grey literature, and both published and unpublished articles from Ethiopian universities. The authors searched the relevant articles conducted on aspiration pneumonia among stroke patients from January 1st, 2024–June 03, 2024. The searching terms were: "incidence," "prevalence," "magnitude," "proportion," "aspiration pneumonia," "aspiration," "pneumonia," "associated factors," "determinant factors," "predictors," "complication," "stroke," "cerebrovascular accident," "post stroke," "post cerebrovascular accident," and "Ethiopia". Boolean operators "AND" and "OR" were used to combine the searching terms (Table 1).

2.3. Screening and eligibility of the studies

All retrieved articles were exported into the "EndNote reference software version 8 (Thomson Reuters, Stamford, CT, USA) citation manager" to sort, clean, and remove possible duplications. Two authors (AG and MA) independently reviewed and evaluated each study based on its relevance, title, and abstracts using predetermined inclusion criteria. Then, all authors (AG, MA, MB, and AW) carefully determined the eligibility of each article. Both published and unpublished articles conducted on aspiration pneumonia among stroke patients in Ethiopia, which were published until December 2024, were included. All studies were measured using the NOS assessment tool. Accordingly, those studies with an adequate sample size, a representative sample size, a minimal non-response rate, ascertainment of exposure, a correct statistical test, and a true assessment of outcome were included in the study. However, interventional studies, trials, systematic reviews and meta-analysis, narrative reviews, qualitative studies, articles without full text after twice emailing the correspondence author, case reports, and policy statements were excluded. In addition, after evaluating each study's attributes using the NOS assessment, low-quality papers were removed from the final analysis. Any disagreement that arose amongst the authors during the process was settled via conversation.

Table 1
Searches on different databases to find articles done on aspiration pneumonia among stroke patients in Ethiopia.

Databases	Searching terms	Number of studies
MEDLINE/ PubMed	"Incidence," OR "prevalence," OR "magnitude," OR "proportion," AND "aspiration pneumonia," OR "aspiration," OR "pneumonia," AND "associated factors," OR "determinant factors," OR "predictors," OR "complication," AND "stroke," OR "cerebrovascular accident," OR "post stroke," OR "post cerebrovascular accident," AND "Ethiopia"	90
Google Scholar	"Incidence," OR "prevalence," OR "magnitude," OR "proportion," AND "aspiration pneumonia," OR "aspiration," OR "pneumonia," AND "associated factors," OR "determinant factors," OR "predictors," OR "complication," AND "stroke," OR "cerebrovascular accident," OR "post stroke," OR "post cerebrovascular accident," AND "Ethiopia"	3050
Other databases	"Incidence," OR "prevalence," OR "magnitude," OR "proportion," AND "aspiration pneumonia," OR "aspiration," OR "pneumonia," AND "associated factors," OR "determinant factors," OR "predictors," OR "complication," AND "stroke," OR "cerebrovascular accident," OR "post stroke," OR "post cerebrovascular accident," AND "Ethiopia"	12
Total retrieved articles		3152
Included studies		21

2.4. Data extraction

On the extraction sheet, the first author's name, study year, publication year, region where the studies were conducted, study design, sample size, and prevalence of aspiration pneumonia were extracted.

2.5. Outcome measurement of the study

The outcome variable in this systematic review and meta-analysis was aspiration pneumonia among stroke patients. Laboratory studies and evidence from alveolar infiltrates were used to measure this outcome variable. Subsequently, individuals with strokes who had positive lab results were classified as having aspiration pneumonia.

2.6. Operational definition

Post-stroke aspiration pneumonia: those patients who were

diagnosed with aspiration pneumonia after the occurrence of a stroke The response variable of this study is a binary variable, aspiration pneumonia (No = 0, Yes = 1).

2.7. Quality assessment

Two authors individually extract the findings from the extraction sheet, and the other two authors validate it. The Newcastle-Ottawa Scale (NOS) was utilized to evaluate the quality of each study based on the following criteria: statistical testing, measurement of exposure or risks, comparability, methodological quality, sample representativeness, and statistical testing. Studies that had a score of at least seven out of ten were considered to be included in the final analysis (Table S2). Each author evaluated the studies on their own to determine which ones should be taken into account and included in the analysis.

2.8. Data processing and analysis

The data were extracted, sorted, and cleaned in a Microsoft Excel spreadsheet before being exported to STATA/MP 17.0 for analysis. A weighted inverse variance random-effects model at a 95 % confidence interval (CI) was used to estimate the pooled prevalence of aspiration pneumonia among stroke patients in Ethiopia. The heterogeneity of the studies was assessed using the Galbraith plot, the Cochrane Q test, and the I^2 with its corresponding p-value. Subgroup analysis was carried out by region, where the studies were conducted, study year, study design, and type of survivors to investigate the cause of heterogeneity. In addition, a sensitivity analysis was performed to look at the possibility of an influential study. Furthermore, a funnel plot and Egger's test were used to assess the possibility of publication bias. Then, a P-value less than 0.05 was deemed statistically significant.

3. Result

3.1. Selection of articles

After searching different databases, 3152 articles were found. Of these articles, 1987 were excluded due to the presence of duplication. Additionally, 879 articles were removed from the analysis after a critical evaluation of the titles and abstracts of each article. Furthermore, 246 studies were excluded due to their irrelevance and inability to fulfil the inclusion criteria. Nineteen articles were also removed due to being unable to get the full text. Then, 21 articles were included in the final analysis (Fig. 1).

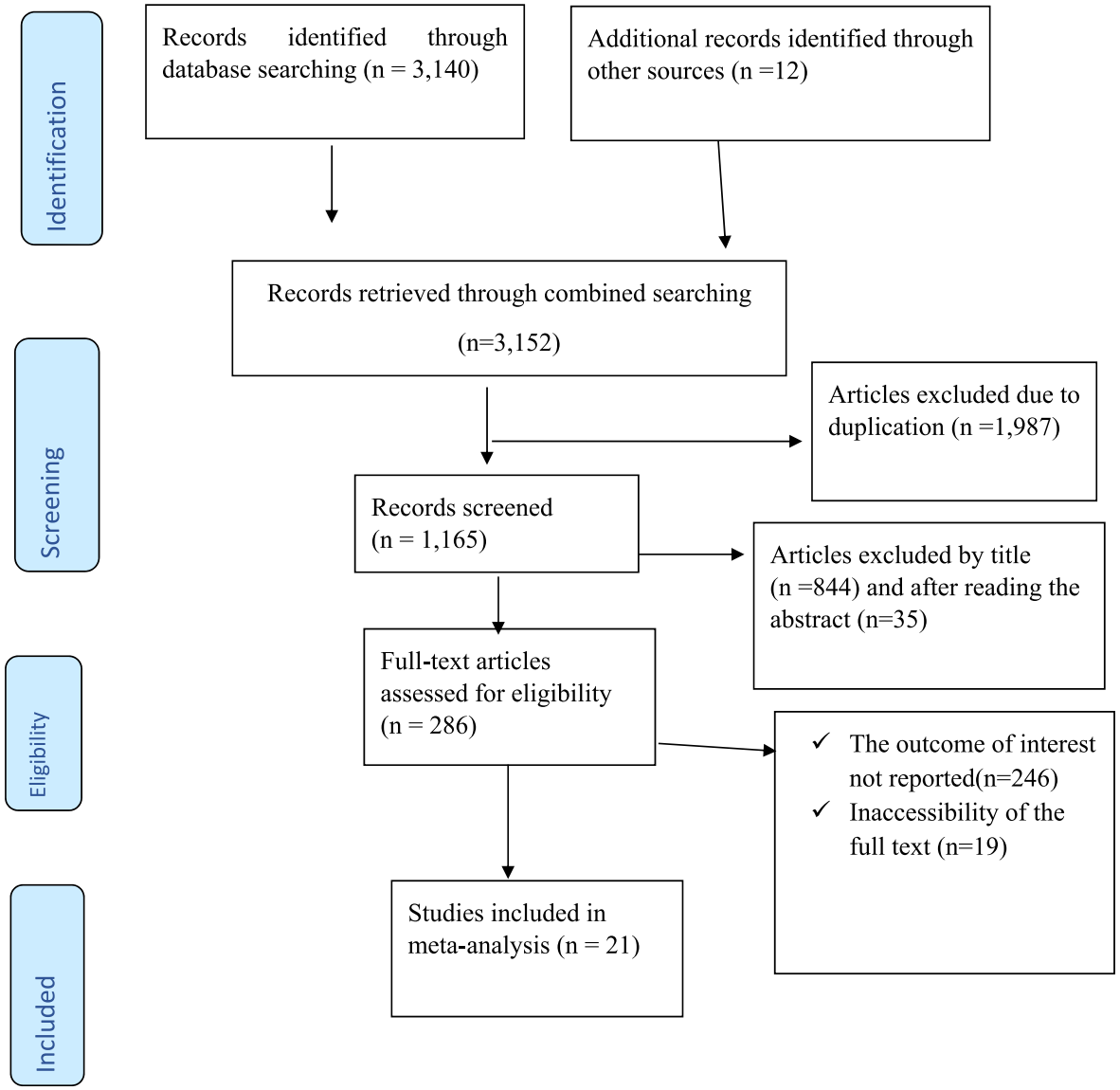

Fig. 1. PRISMA flow chart of selection of articles for systematic review and meta-analysis of aspiration pneumonia among stroke patients in Ethiopia.

3.2. Characteristics of the studies and study participants

In this systematic review and meta-analysis, 21 articles with 4722 study participants were included. The studies were conducted in different regions of Ethiopia until December 25/2024. Of these studies, five were conducted after 2020 and fifteen were done before 2020. Eight studies were carried out in Amhara region,[13–20] five were conducted in Oromia region,[21–25] four were done in Tigray region,[26–29] two were done in Harar region[30,31] and two were in Addis Ababa.[32,33] The sample size ranged from 71 to 568. In design, four studies were cross-sectional, four were prospective cohort, and twelve were retrospective follow up (Table 2).

4. Meta-analysis

4.1. Pooled prevalence of aspiration pneumonia

This systematic review and meta-analysis showed that, the pooled prevalence of aspiration pneumonia among stroke patients in Ethiopia was 31.65 % (95 % CI: 25.30–38.01) (Fig. 2).

4.2. Publication bias

The asymmetrical distribution of the included articles was visible in the funnel plot, and Egger's test revealed a statistically significant result ($p = 0.001$), indicating the possibility of publication bias (Fig. 3A). To manage publication bias, a trim and fill analysis was done. After trim and fill analysis, 30 studies were found, which resulted in 20.23 % (95 % CI: 13.45–27.01 %) of the bias-adjusted prevalence of aspiration pneumonia (Fig. 3B).

4.3. Heterogeneity

Visual examination of the Galbraith plot reveals the presence of significant heterogeneity (I^2 96.55 %, $p < 0.001$) (Fig. S1).

4.4. Sub-group analysis and meta-regression

Sub-group analysis was performed using the region where the studies were done, study year, and study design to detect the source of heterogeneity. Research articles conducted in Addis Ababa and Harar revealed the higher prevalence of aspiration pneumonia among stroke patients: 37.67 % (95 % CI: 31.56, 43.78). Similarly, research articles carried out before 2020 showed the highest prevalence of aspiration pneumonia: 32.97 % (95 % CI: 24.96, 40.98). Studies done using a cross-sectional study design revealed the highest proportion of aspiration pneumonia: 36.75 (95 % CI: 32.11, 41.38) (Table 3). In addition, meta-regression was carried out to detect the possible source of heterogeneity. Accordingly, meta-regression using the moderator sample size and study year was done. The result of this meta-regression showed that the study year had a coefficient of 0.0007, a standard error of 0.0057, and a P value of 0.898, whereas the coefficient, standard error, and p value of the sample size were −0.119, 0.0115, and <0.001, respectively. Therefore, sample size is the source of heterogeneity ($P < 0.001$).

4.5. Sensitivity analysis

A leave-one-point sensitivity analysis conducted using the random-effects model revealed that all of the points were estimates within the overall 95 % confidence interval (25.30–38.01), indicating the absence of any influential study (Fig. S2).

5. Discussion

In this study, the pooled prevalence of aspiration pneumonia among stroke patients was 31.65 % (95 % CI: 25.30–38.01). The findings of this study were higher than those of studies conducted in United States of America (5 %),[34] Japan (24.5 %), United Kingdom (7.12 %),[35] and China (13.20 %).[36] The discrepancy may be due to differences in study settings, the level of post-stroke patient care, the diagnosis approaches of post-stroke aspiration pneumonia, or the study design used. This is supported by a study done in developing countries, which concluded that there are more similarities than differences between developing and developed countries in the epidemiology of stroke. Compared to urban stroke patients, rural ones are less likely to be optimally investigated and treated.[37]

The prevalence of aspiration pneumonia among stroke patients varies within the region where the studies were conducted. As a result, research done in Addis Ababa reported the highest prevalence of aspiration pneumonia: 37.67 % (95 % CI: 31.56, 43.78), and the lowest prevalence was observed in Oromia region: 29.87 % (95 % CI: 10.55, 49.20). The fact that patients in Addis Ababa were being treated in referral hospitals for their severe illnesses while the most seriously ill patients in Addis Ababa were found to receive specialized diagnosis and

Table 2
Characteristics of included studies on aspiration pneumonia among stroke patients in Ethiopia.

Author	Study year	Region	Study design	Sample size	Prevalence of AP (%)	NOS
Abdela SG et al., 2019[13]	2017	Amhara	Cross-sectional	151	29.8	8
Adem F et al., 2023[31]	2019	Harere	Retrospective follow up	112	34.8	7
Asres AK et al., 2020[33]	2018	Addis Ababa	Retrospective follow up	170	39.4	8
Assefa M et al., 2022[14]	2020	Amhara	Cross-sectional	325	36.0	9
Ayele Z et al., 2023[38]	2021	Harere	Cross-sectional	290	37.9	7
Beyene N et al., 2022[22]	1017	Oromia	Retrospective follow up	153	30.1	8
Fekadu G et al., 2019[21]	2017	Oromia	Prospective cohort	116	19.8	8
Gadisa DB et al., 2020[25]	2019	Oromia	Retrospective follow up	111	66.7	9
Gidey K et al., 2023[26]	2018	Tigray	Prospective cohort	272	11.8	7
Greffie ES et al., 2015[15]	2013	Amhara	Retrospective follow up	98	19.4	7
Hailu A et al., 2023[27]	2018	Tigray	Prospective cohort	157	40.1	8
Kefale B et al., 2020[16]	2019	Amhara	Retrospective follow up	194	64.4	8
Lidetu T et al., 2023[17]	2021	Amhara	Retrospective follow up	568	23.1	9
Mamushet Y et al., 2015[32]	2009	Addis Ababa	Prospective cohort	71	33.8	8
Mosisa W et al., 2023[24]	2022	Oromia	Retrospective follow up	480	26.5	8
Mulugeta H et al., 2020[18]	2019	Amhara	Retrospective follow up	162	26.5	9
Shenkutie E et al., 2015[19]	2013	Amhara	Retrospective follow up	240	24.2	8
Admas A et al., 2022[20]	2020	Amhara	Retrospective follow up	382	15.4	8
Weldegebreal S et al., 2020[28]	2018	Tigray	Cross-sectional	216	42.6	7
Zewudie AZ et al., 2020[23]	2018	Oromia	Retrospective follow up	220	7.3	8
Asgedom SW et al., 2020[29]	2019	Tigray	Retrospective follow up	234	39.4	7

AP: Aspiration Pneumonia, NOS: Newcastle-Ottawa Scale.

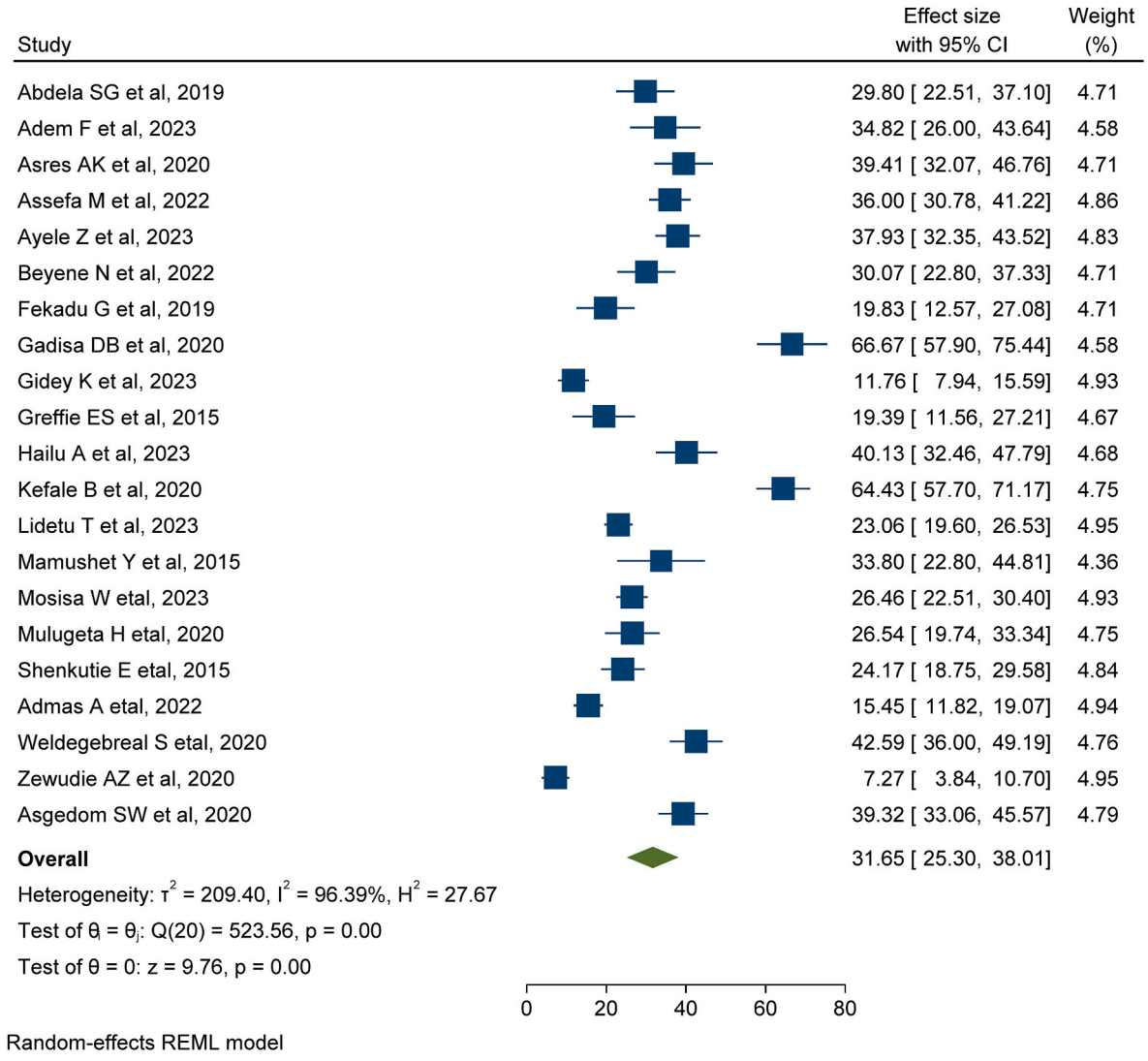

Fig. 2. Forest plot on the pooled prevalence of aspiration pneumonia among stroke patients in Ethiopia.

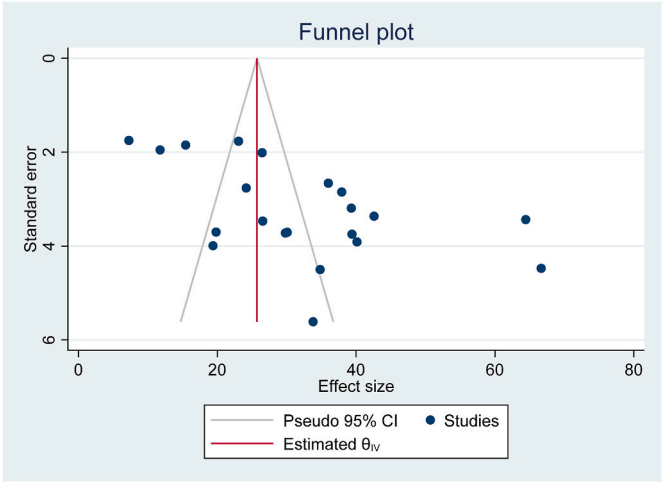

Fig. 3A. Funnel plot with 95 % confidence limits on the pooled prevalence of aspiration pneumonia among stroke patients in Ethiopia.

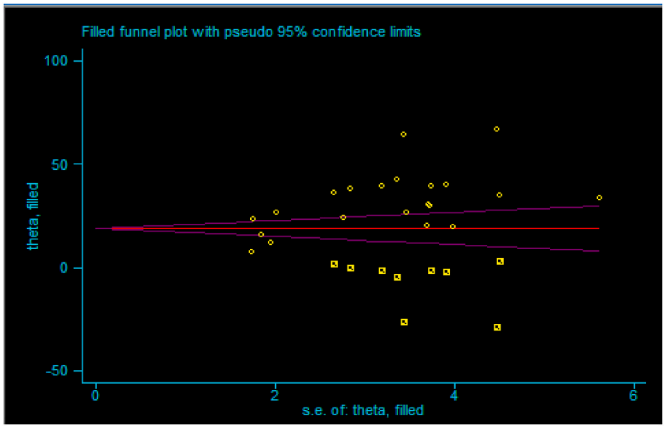

Fig. 3B. Trim and fill analysis plot with 95 % confidence limits on the pooled prevalence of aspiration pneumonia among stroke patients in Ethiopia.

care could be one reason for the gap. Due to increased case load in Addis Ababa, the probability of increased aspiration pneumonia will increase. Furthermore, the prevalence of aspiration pneumonia was higher among studies conducted in Harar. A possible explanation for this association

Table 3
Sub-group analysis on the pooled prevalence of aspiration pneumonia among stroke patients in Ethiopia.

Variables	Subgroup	Studies (n)	Prevalence (95%CI)	I^2 (%)	P-value
Region, where studies were done	Addis Ababa	2	37.67 (31.56,43.78)	0.00	0.41
	Amhara	8	29.78 (19.23,40.32)	96.88	<0.001
	Oromia	5	29.87 (10.55,49.20)	98.45	<0.001
	Tigray	4	33.24 (18.73,47.75)	95.93	<0.001
	Harar	2	37.67 (31.56,43.78)	0.00	0.56
Study year	Before 2020	16	32.97 (24.96,40.98)	96.11	<0.001
	2020 and after 2020	5	27.60 (17.47,35,73)	94.62	<0.001
Study design	Cross-sectional	4	36.75 (32.11,41.38)	56.67	0.08
	Prospective follow up	4	25.95 (13.02,38.87)	92.92	<0.001
	Retrospective follow up	13	31.88 (22.49,41.28)	97.56	<0.001

CI: Confidence Interval.

might be due to their vulnerabilities and higher chances of risky exposures like alcohol drinking, Khat chewing, and smoking cigarettes, which may contribute to a to a high risk of aspiration pneumonia.[38]

Similarly, articles carried out before 2020 reported a higher prevalence of aspiration pneumonia among stroke patients: 32.97 % (95 % CI: 24.96, 40.98) than studies conducted in 2020 and after 2020: 27.60 % (95 % CI: 17.47, 35.73). The probable reason might be that only five studies with a relatively larger sample size that were conducted after 2020 were included in the analysis, which might contribute to the higher percentage of aspiration pneumonia among stroke patients. In addition, the presence of technological advancements from year to year provides specialized diagnostic techniques and advanced treatments, which help in the early detection and treatment of stroke patients.

This evidence is supported by a study that concludes that the emerging technology has rapidly integrated with multiple fields of medicine, including stroke. Thus, the presence of new algorithms is known to have a significant effect on the early detection and treatment of stroke, which helps to prevent stroke-associated aspiration pneumonia.[39] Furthermore, research articles with cross-sectional study design revealed a higher prevalence of aspiration pneumonia: 36.75 % (95 % CI: 32.11, 41.38) than studies conducted using follow-up design. This might be due to the fact that studies conducted using a cross-sectional study design report a point prevalence that is vulnerable to different confounders that may falsely increase the outcome variable. This evidence is guided by the fact that, unlike studies starting with a series of patients, cross-sectional studies often need to select a sample of subjects from a large and heterogeneous study population. Thus, they are susceptible to sampling bias.[40]

5.1. Strength and limitation of the study

A comprehensive literature review with a clear focus on a specific patient population and condition, the use of robust statistical methods to analysis pooled data, and detailed subgroup analysis to identify sources of heterogeneity and regional differences were the strengths of the study. However, significant heterogeneity among included studies, which might affect the reliability of pooled estimates, limited studies conducted in Ethiopia, which may not be generalizable to other settings, and the absence of a registered protocol in PROSPERO, which is a common practice for systematic reviews, were the limitations of the study. In addition, the presence of potential publication bias and the exclusion of non-English studies were also considered limitations.

5.2. Conclusion and recommendations

Nearly one-third of stroke patients developed aspiration pneumonia. There is regional variation regarding the prevalence of aspiration pneumonia. The highest prevalence was reported in Addis Ababa and Harar regions, while the lowest was reported in Amhara and Oromia regions. As a result, early detection, treatment, and control of stroke are advisable to prevent the occurrence of aspiration pneumonia.

Availability of data and materials

All related data have been presented within the manuscript. The dataset supporting the conclusions of this article is available from the authors on request.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Author's contributions

AG and MA designed the study, designed and run the literature search. All authors (AG, MA, MB, and AW) acquired data, screened records, extracted data, and assessed the risk of bias. AG did the statistical analyses and wrote the report. All authors provided critical conceptual input, analyzed and interpreted the data, and critically revised the report. All authors read and approved the final manuscript.

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Declaration of competing interest

The authors declared that they have no competing interests.

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Not applicable.

Abbreviations

AJOL	African Journals Online
CI	Confidence Interval
NOS	Newcastle Ottawa Scale
PRISMA	Preferred Reporting Items for Systematic Review and Meta-analysis

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cegh.2024.101707.

References

1. Murphy SJ, Werring DJ. Stroke: causes and clinical features. *Medicine*. 2020;48(9):561–566.
2. Armstrong JR, Mosher BD. Aspiration pneumonia after stroke: intervention and prevention. *Neurohospitalist*. 2011;1(2):85–93.
3. Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with stroke in Northeast Nigeria. *Int J Stroke*. 2013 Jun 1;8(4).

4. Belal ES, Selim S, Aboul fotouh AM, Mohammad A. Detection of airway protective level of the cough reflex in acute stroke patients. *Egypt J Neurol Psychiatr Neurosurg*. 2020;56:1–6.
5. Longo DL, Mandell L, Niederman M. Aspiration pneumonia. *N Engl J Med*. 2019;380 (7):651–663.
6. Makhnevich A, Feldhamer KH, Kast CL, Sinvani L. Aspiration pneumonia in older adults. *J Hosp Med*. 2019;14(7):429–435.
7. Chen S, Kent B, Cui Y. Interventions to prevent aspiration in older adults with dysphagia living in nursing homes: a scoping review. *BMC Geriatr*. 2021;21(1):1–14.
8. Ali A, Howe J, Majid A, Redgrave J, Pownall S, Abdelhafiz A. The economic cost of stroke-associated pneumonia in a UK setting. *Top Stroke Rehabil*. 2018;25(3): 214–223.
9. Kishore AK, Vail A, Chamorro A, et al. How is pneumonia diagnosed in clinical stroke research? A systematic review and meta-analysis. *Stroke*. 2015;46(5): 1202–1209.
10. Prust ML, Nutakki A, Habanyama G, et al. Aspiration pneumonia in adults hospitalized with stroke at a large academic hospital in Zambia. *Neurology: Clin Pract*. 2021;11(6):e840–e847.
11. Watanabe S, Shimozato K, Oh-Shige H, et al. Examination of factors associated with aspiration pneumonia following stroke. *Oral Sci Int*. 2014;11(1):15–21.
12. Schwarz M, Coccetti A, Murdoch A, Cardell E. The impact of aspiration pneumonia and nasogastric feeding on clinical outcomes in stroke patients: a retrospective cohort study. *J Clin Nurs*. 2018;27(1-2):e235–e241.
13. Abdella SG, Gebi NB, Gerffie ES, Tamirat KS. *Clinical Profile, In-Hospital Outcome and Associated Factors of Stroke after the Start of a Standard Organized Stroke Care Unit at University of Gondar Hospital, Northwest Ethiopia*. 2019.
14. Assefa M, Tadesse A, Adane A, Yimer M, Tadesse M. Factors associated with stroke associated pneumonia among adult stroke patients admitted to university of Gondar hospital, Northwest Ethiopia. *Sci Rep*. 2022;12(1), 12724.
15. Greffie ES, Mitiku T, Getahun S. Risk factors, clinical pattern and outcome of stroke in a referral hospital, Northwest Ethiopia. *Clin Med Res*. 2015;4(6):182–188.
16. Kefale B, Ewunetei A, Molla M, Tegegne GT, Degu A. Clinical pattern and predictors of stroke treatment outcome among hospitalised patients who had a stroke at Felege Hiwot comprehensive specialised hospital, northwest Ethiopia: a retrospective cross-sectional study. *BMJ Open*. 2020;10(12), e040238.
17. Lidetu T, Muluneh EK, Wassie GT. Incidence and predictors of aspiration pneumonia among stroke patients in Western Amhara region, North-west Ethiopia: a retrospective follow up study. *Int J Gen Med*. 2023:1303–1315.
18. Mulugeta H, Yehuala A, Haile D, et al. Magnitude, risk factors and outcomes of stroke at Debre Markos Referral Hospital, Northwest Ethiopia: a retrospective observational study. *Egypt J Neurol Psychiatr Neurosurg*. 2020;56:1–9.
19. Shenkutie E. *Stroke: Clinical Pattern, Mortality and Associated Factors in a Referral Hospital, Northwest Ethiopia*. 2015.
20. Admas M, Teshome M, Petrucka P, Telayneh AT, Alamirew NM. *In-hospital mortality and its predictors among adult stroke patients admitted in Debre Markos Comprehensive Specialized Hospital*. In: *Northwest Ethiopia*. 10. SAGE Open Medicine; 2022, 20503121221122465.
21. Fekadu G, Chelkeba L, Melaku T, et al. Management protocols and encountered complications among stroke patients admitted to stroke unit of Jimma university medical center, Southwest Ethiopia: prospective observational study. *Ann Med Surg*. 2019;48:135–143.
22. Beyene N, Fanta K, Tatiparthi R. Pharmacotherapy pattern and treatment outcomes of stroke patients admitted to Jimma university medical center, Ethiopia. *Patient Relat Outcome Meas*. 2021:267–275.
23. Zewudie AZ, Regasa T, Hambisa S, et al. *Treatment outcome and its determinants among patients admitted to stroke unit of Jimma university medical center, Southwest Ethiopia. Stroke Research and Treatment*. 2020:2020.
24. Mosisa W, Gezehagn Y, Kune G, Chego M, Yigezu HF, Getnet M. Survival status and predictors of mortality among adult Stroke patients admitted to Jimma University Medical Center, South west Ethiopia: a retrospective Cohort study. *Vasc Health Risk Manag*. 2023:527–541.
25. Gadisa DA, Busawa GB, Gebremariam ET, et al. Clinical characteristics, treatment outcomes, and its predictors among hospitalized stroke patients in ambo university referral hospital, West Ethiopia: a retrospective hospital-based study. *Vasc Health Risk Manag*. 2021:591–604.
26. Gidey K, Hailu A. A prospective study of stroke characteristics, risk factors, and mortality in a Tertiary hospital of Northern Ethiopia. *Int J Gen Med*. 2023: 5051–5061.
27. Hailu A, Gidey K, Ebrahim MM, et al. Patterns of medical admissions and predictors of mortality in Ayder comprehensive specialized hospital, Northern Ethiopia: a prospective observational study. *Int J Gen Med*. 2023:243–257.
28. Weldegebreal S, Gidey K, Gidey K, Nirayo YL, Desta DM, Atey TM. *Management outcome, mortality and factors associated with mortality amongst hospitalized patients with stroke. A Cross Sectional Study*. 2020.
29. Asgedom SW, Gidey K, Gidey K, Niriayo YL, Desta DM, Atey TM. Medical complications and mortality of hospitalized stroke patients. *J Stroke Cerebrovasc Dis*. 2020;29(8), 104990.
30. Mideksa S, Ambachew S, Biadgo B, Baynes HW. Glycemic control and its associated factors among diabetes BioMed research international 11mellitus patients at ayder comprehensive specialized hospital, Mekelle-Ethiopia. *Adipocyte*. 2018;7(3): 197–203. Journal of Ayub Medical College Abbottabad.
31. Adem F, Mohammed B, Nigussie S. *In-hospital Treatment Outcomes of Acute Stroke and Determinant Factors in a Teaching Hospital in Eastern Ethiopia*. 11. SAGE Open Medicine; 2023, 20503121221149537.
32. Mamushet Y, Zenebe G, Addissie A. Medical and neurological complications among stroke patients admitted for inpatient care in Addis Ababa, Ethiopia. *Ethiop Med J*. 2015;53(1):9–17.
33. Asres AK, Cherie A, Bedada T, Gebrekidan H. Frequency, nursing managements and stroke patients' outcomes among patients admitted to Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia a retrospective, institution based cross-sectional study. *Int J Afr Nurs Sci*. 2020;13, 100228.
34. Hassan AE, Chaudhry SA, Zacharatos H, et al. Increased rate of aspiration pneumonia and poor discharge outcome among acute ischemic stroke patients following intubation for endovascular treatment. *Neurocritical Care*. 2012;16: 246–250.
35. Matsumura T, Mitani Y, Oki Y, Fujimoto Y, Ishikawa A. Risk factors for the onset of aspiration pneumonia among stroke patients in the recovery stage. *Nihon Ronen Igakkai zasshi Jpn J Geriatr*. 2014;51(4):364–368.
36. Chang C-Y, Cheng T-J, Lin C-Y, Chen J-Y, Lu T-H, Kawachi I. Reporting of aspiration pneumonia or choking as a cause of death in patients who died with stroke. *Stroke*. 2013;44(4):1182–1185.
37. Sridharan SE, Unnikrishnan J, Sukumaran S, et al. Incidence, types, risk factors, and outcome of stroke in a developing country: the Trivandrum Stroke Registry. *Stroke*. 2009;40(4):1212–1218.
38. Ayele ZA, Molla S, Ahmed A, Worku T, Bezabih AS, Mamo BT. Poor treatment outcomes and associated factors among hospitalized patients with stroke at Hiwot Fana Comprehensive Specialized Hospital, eastern Ethiopia. *Front Stroke*. 2023;2, 1304664.
39. Mainali S, Darsie ME, Smetana KS. Machine learning in action: stroke diagnosis and outcome prediction. *Front Neurol*. 2021;12, 734345.
40. Wang X, Cheng Z. Cross-sectional studies: strengths, weaknesses, and recommendations. *Chest*. 2020;158(1):S65–S71.