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Pneumococcal vaccination and aspiration pneumonia in super-aged societies: A scoping review of the evidence landscape

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Abstract: Aspiration pneumonia is the leading cause of pneumonia-related death in Japan, where 29.3% of the population is aged ≥ 65 years, and it represents a growing challenge across rapidly aging Asian societies. Although pneumococcal vaccination is widely implemented for older adults, its effectiveness specifically against aspiration pneumonia remains unestablished. This scoping review systematically mapped the existing evidence on pneumococcal vaccination effectiveness for aspiration pneumonia prevention. Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines, PubMed, Cochrane Library, and Cumulative Index to Nursing and Allied Health Literature (CINAHL) were searched, identifying five studies (three primary studies and two reviews). None directly evaluated vaccine effectiveness with aspiration pneumonia as a defined outcome. Indirect evidence from studies including aspiration pneumonia within composite pneumonia outcomes suggests potential benefits; however, vaccine-specific effects could not be isolated. This review identifies a structural misalignment between the predominant pneumonia phenotype in super-aged societies and existing vaccine evaluation frameworks, and demonstrates that aspiration pneumonia has been systematically overlooked as a prespecified outcome in vaccine effectiveness research. Notably, the absence of direct evidence reflects limitations in study design and outcome definition, rather than evidence of vaccine ineffectiveness. Dedicated clinical studies are warranted to inform evidence-based immunization policies.

***Keywords*:** aspiration pneumonia, pneumococcal vaccination, aged, *Streptococcus pneumoniae*, scoping review

1. Introduction

Aspiration pneumonia represents a significant and growing healthcare burden in aging societies. Japan, the world's most aged society with 29.3% of its population aged ≥ 65 years in 2024 (*1*), faces an urgent challenge in managing aspiration pneumonia. Other Asian countries are encountering similar demographic shifts. South Korea joined the ranks of super-aged societies in December 2024, with 20% of its population aged ≥ 65 years (*2*). In older adults, aspiration pneumonia is associated with high mortality, frequent recurrence, and prolonged hospitalization (*3,4*). Accordingly, developing effective prevention strategies has become a priority in geriatric medicine and public health across rapidly aging Asian societies.

Pneumococcal vaccination has demonstrated effectiveness in preventing invasive pneumococcal disease and pneumococcal pneumonia in adults (*5,6*). Many countries have implemented national immunization programs targeting older populations. South Korea and Japan introduced routine pneumococcal vaccination for adults aged ≥ 65 years in 2013 and 2014, respectively. More recently, a 21-valent pneumococcal conjugate vaccine designed for adults showed robust immunogenicity against serotypes responsible for approximately 83% of invasive pneumococcal disease in individuals aged ≥ 65 years (*7–9*). However, whether this protective effect extends to aspiration pneumonia, a condition with distinct pathophysiological mechanisms and potentially different microbial etiologies, remains unclear. *Streptococcus pneumoniae* is clinically relevant in aspiration pneumonia (*10,11*), providing a theoretical rationale for investigating pneumococcal vaccination as a potential preventive strategy.

To the best of our knowledge, no previous review has systematically examined the effectiveness of pneumococcal vaccination specifically for the prevention of aspiration pneumonia, despite its substantial clinical burden. This gap reflects a structural misalignment between the predominant pneumonia phenotype in super-aged societies and existing vaccine evaluation

frameworks, in which aspiration pneumonia has been systematically overlooked as a prespecified outcome. Therefore, this scoping review aims to map the existing evidence on the effectiveness of pneumococcal vaccination for aspiration pneumonia prevention, identify gaps in the current literature, and propose directions for future research.

2. Literature search strategy and process

2.1. Protocol

A scoping review is a methodology used to rapidly map key concepts within a research area, as well as the available sources of information and evidence (*12*). This scoping review adhered to the Joanna Briggs Institute methodology for scoping reviews (*13*) and was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines (*14*).

2.2. Eligibility criteria

Studies were included if they: *i*) evaluated the effectiveness or efficacy of pneumococcal vaccines; *ii*) included populations with aspiration pneumonia, dysphagia, or swallowing disorders; *iii*) reported clinical outcomes related to pneumonia prevention, recurrence, hospitalization, or mortality; and *iv*) were published in English.

Studies were excluded if they: *i*) were animal studies; *ii*) involved pediatric populations (age < 18 years); *iii*) were published in languages other than English; or *iv*) did not report efficacy data.

2.3. Information sources and search strategy

A systematic search was conducted on November 30, 2025, across three electronic databases: PubMed, Cochrane Library, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). The search strategy combined terms related to aspiration pneumonia and pneumococcal vaccination using the following search string:

("aspiration pneumonia" OR "deglutition disorders" OR "dysphagia") AND ("pneumococcal vaccine" OR "pneumococcal vaccination" OR "PPSV23" OR "PCV13" OR "PCV15" OR "PCV20" OR "PCV21" OR "pneumococcal polysaccharide vaccine" OR "pneumococcal conjugate vaccine")

No date restrictions were applied. Citation tracking of the included review articles was conducted to identify additional relevant studies. Notably, this search strategy intentionally required explicit aspiration-related terms to assess whether aspiration pneumonia has been recognized as a distinct and prespecified evaluative outcome in vaccine effectiveness research. This approach differs from searches targeting studies conducted in aspiration-prone populations (*e.g.*, nursing home residents or patients with dysphagia) without explicit aspiration-related outcome labeling. The rationale for this decision is discussed further in the Limitations section.

2.4. Selection of sources of evidence

Retrieved records were deduplicated and screened based on titles and abstracts. Title and abstract screening was initially conducted by one researcher and subsequently verified by a second researcher. Articles that met the inclusion criteria underwent full-text review, and ambiguous cases were resolved by consensus between two researchers. Full-text articles from potentially eligible studies were obtained and assessed according to the predefined inclusion and exclusion criteria. Although scoping reviews typically exclude review articles to prevent double-counting, we retained review articles in this study for two purposes: *i*) citation tracking to identify additional primary studies and *ii*) contextualizing the findings in the Synthesis and Implications section by referencing expert perspectives on aspiration pneumonia management. The evidence synthesis and identification of research gaps in the Evidence Overview section were based exclusively on primary studies.

2.5. Data charting process

The following data were extracted from the included studies: author, publication year, country, study design, population characteristics, sample size, vaccine type, and key findings related to aspiration pneumonia and pneumococcal vaccination.

3. Evidence overview

3.1. Study selection

The database search yielded 21 records (PubMed: 8, Cochrane Library: 2, CINAHL: 11). After removing 9 duplicates, 12 unique records underwent title and abstract screening. Six records were excluded during title and abstract screening: 4 animal studies, 1 pediatric study, and 1 article published in Chinese. Six records underwent full-text review, of which two were excluded: one cross-sectional survey without efficacy data (*15*) and one review article without specific discussion of aspiration pneumonia prevention (*16*). Ultimately, two primary studies (*17,18*) and two review articles (*3,4*) were included from the database search. Citation tracking of the included review articles identified one additional primary study (*19*), resulting in a total of five studies (three primary studies and two review articles) in the final synthesis (Figure 1).

3.2. Study characteristics

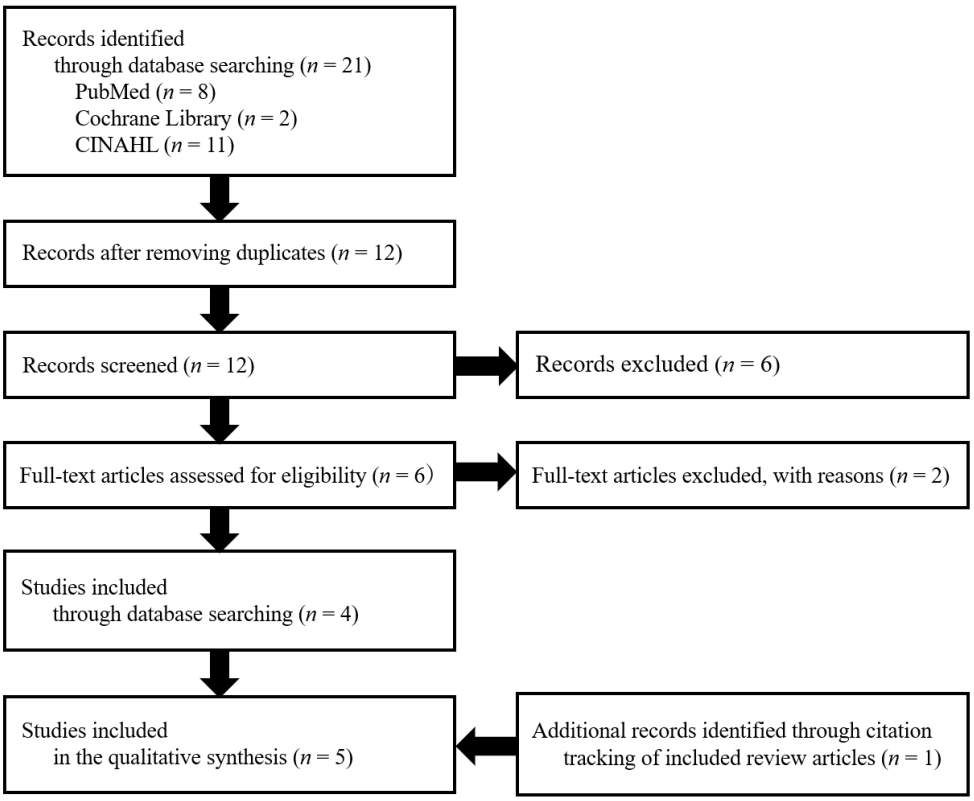

Figure 1. PRISMA-ScR flow diagram of study selection.

The five included studies comprised three primary studies and two review articles, published between 2003 and 2021. The primary studies were conducted in Singapore, Spain, and Sweden, and employed diverse methodological approaches, including a randomized controlled trial, a prospective cohort study, and a retrospective cohort study. Study populations ranged from 123 to more than 259,000 participants, all focusing on older individuals aged ≥ 65 years. The characteristics of the included studies are summarized in Table 1.

3.3. Synthesis of findings

A synthesis of the included studies revealed no direct evidence regarding the effectiveness of pneumococcal vaccination specifically for the prevention of aspiration pneumonia. The available evidence was derived from broader pneumonia populations or from theoretical considerations presented in review articles.

3.3.1. Direct evidence for aspiration pneumonia

None of the included studies directly evaluated the effectiveness of pneumococcal vaccination in preventing aspiration pneumonia as either a primary or secondary outcome.

3.3.2. Indirect evidence from related populations

Although no study directly evaluated aspiration pneumonia as a primary outcome, the available evidence suggests a potential vaccine benefit in aspiration-prone populations.

Hedlund *et al.* (*19*) conducted a large-scale retrospective cohort study evaluating influenza and pneumococcal vaccination in 259,627 older individuals. Notably, the outcome measure "pneumonia" explicitly included aspiration pneumonia (International Classification of Diseases, 10th Revision [ICD-10]: J69.0) alongside other pneumonia categories (ICD-10: J12–J18). Vaccinated individuals had significantly lower rates of hospital admission for pneumonia (relative risk [RR] = 0.78, 95% confidence interval [CI]: 0.71–0.86) and invasive pneumococcal disease (RR = 0.46, 95% CI: 0.25–0.87). The protective effect against pneumonia persisted during the non-influenza seasons (RR, 0.88), suggesting independent pneumococcal vaccine efficacy. Although these findings indicate a potential benefit in populations that include patients with aspiration pneumonia, the study did not report separate outcomes specifically for aspiration pneumonia.

Garcia-Vidal *et al.*(*17*) analyzed recurrent community-acquired pneumonia (CAP) episodes in 1,556 hospitalized patients and found that aspiration pneumonia was more prevalent among those with recurrent CAP episodes (10.3%) than among those without recurrence (5.7%). Lack of pneumococcal vaccination was identified

Table 1. Characteristics of the included studies

Authors, Year (*Ref.*)	Country	Study Design	Population	Sample Size	Vaccine Type	Key Findings
Primary Studies						
Hedlund *et al.*, 2003 (*19*)	Sweden	Retrospective cohort	Adults aged ≥ 65 years	259,627	PPSV23 + Influenza	Pneumonia outcome included aspiration pneumonia (ICD-10: J69.0). Vaccination reduced pneumonia hospitalization (RR = 0.78) and invasive pneumococcal disease (IPD) (RR = 0.46). This effect persisted in the non-influenza season.
Garcia-Vidal *et al*., 2009 (*17*)	Spain	Prospective cohort	Hospitalized patients with CAP	1,556	PPSV23	Aspiration pneumonia was more common in patients with recurrent CAP (10.3% *vs.* 5.7%). Lack of vaccination was associated with CAP recurrence (OR = 1.91). No direct analysis of the effect of the vaccine on aspiration pneumonia was performed.
Rosario *et al.*, 2021 (*18*)	Singapore	RCT	Geriatric inpatients aged ≥65 years	123	PCV13 + Influenza	Multi-component intervention including vaccination reduced respiratory rehospitalization (18.6% *vs.* 34.4%). Vaccine effect was not isolatable from other interventions.
Review Articles						
Teramoto *et al.*, 2015 (*3*)	Japan	Narrative review	Older patients with aspiration pneumonia	N/A	—	Vaccination was discussed as prevention strategy and cited Hedlund *et al.* (*19*) for vaccine effectiveness evidence.
Janssens, 2005 (*4*)	Switzerland	Narrative review	Older patients with pneumonia	N/A	—	Addressed pneumococcal vaccination in older patients and Referenced Hedlund *et al.* (*19*).

Abbreviations: CAP, community-acquired pneumonia; ICD-10, International Classification of Diseases 10th Revision; IPD, invasive pneumococcal disease; PCV13, 13-valent pneumococcal conjugate vaccine; PPSV23, 23-valent pneumococcal polysaccharide vaccine; RCT, randomized controlled trial; RR, relative risk; OR, odds ratio.

as an independent risk factor for CAP recurrence (odds ratio [OR] = 1.91, 95% CI: 1.30–2.80). However, this study did not examine whether pneumococcal vaccination specifically reduced recurrence of aspiration pneumonia, and no direct association was established between these findings.

Rosario *et al.* (*18*) implemented pneumococcal vaccination as part of a multicomponent intervention in older patients at high risk of aspiration and demonstrated reduced respiratory infection–related rehospitalization (18.6% *vs*. 34.4%). This finding is consistent with a potential benefit of vaccination as part of comprehensive prevention strategies; however, the study design precluded isolation of vaccine-specific effects from other intervention components.

3.3.3. Review article perspectives

Teramoto *et al.* (*3*) and Janssens (*4*) cited Hedlund *et al.* (*19*) in discussing the potential benefits of pneumococcal vaccination for preventing recurrent pneumonia in older patients, including those at risk of aspiration. These reviews suggest that vaccination may be beneficial based on evidence from the general older population; however, neither review provided additional primary data specific to aspiration pneumonia.

3.3.4. Summary of evidence landscape

This scoping review, based exclusively on primary studies, identified several critical evidence gaps: *i*) no studies evaluated pneumococcal vaccination effectiveness with aspiration pneumonia as a clearly defined outcome; *ii*) no data examined whether the association between pneumococcal vaccination and reduced CAP recurrence extends specifically to aspiration pneumonia; and *iii*) understanding of the contribution of pneumococci to aspiration pneumonia etiology in contemporary patient populations remains limited. In summary, none of the included primary studies provided direct evidence of pneumococcal vaccine effectiveness with aspiration pneumonia as a prespecified outcome; the available indirect evidence was derived from studies using composite pneumonia outcomes, multicomponent interventions in which vaccine-specific effects could not be isolated, and associative findings requiring additional inferential steps.

4. Synthesis and implications

4.1. Summary of main findings

This scoping review systematically examined the evidence on the effectiveness of pneumococcal vaccination for preventing aspiration pneumonia. The search identified three primary studies and two review articles that met the inclusion criteria; however, none directly evaluated pneumococcal vaccination effectiveness with aspiration pneumonia as a clearly defined outcome. Importantly, the absence of direct evidence reflects a structural gap in research design and outcome definition rather than demonstrated vaccine ineffectiveness. Hedlund *et al.* (*19*) reported reduced pneumonia-related hospitalizations in vaccinated older individuals, with aspiration pneumonia included within the composite pneumonia outcome; however, aspiration pneumonia was not reported separately. Garcia-Vidal *et al.* (*17*) identified aspiration pneumonia as a risk factor for recurrent CAP and lack of pneumococcal vaccination as an independent predictor of recurrence, findings that are consistent with a potential benefit of vaccination in aspiration-prone patients, although no direct association was established. Rosario *et al.* (*18*) demonstrated reduced respiratory infection–related rehospitalization with a multicomponent intervention that included pneumococcal vaccination, suggesting that vaccination may contribute to comprehensive prevention strategies; however, vaccine-specific effects could not be isolated. Collectively, these findings highlight the need for studies that directly examine the relationship between pneumococcal vaccination and aspiration pneumonia.

4.2. Clinical burden of aspiration pneumonia

The importance of addressing this evidence gap is underscored by the clinical significance of aspiration pneumonia. Among older adults, aspiration pneumonia is common and is associated with hospital mortality rates of approximately 10–15%, which increase with advancing age and the presence of swallowing abnormalities (*20,21*). This substantial burden provides a strong rationale for investigating vaccine effectiveness against aspiration pneumonia. The reported proportion of aspiration pneumonia among all pneumonia cases is notably high in Japan at 40–70% (*22-25*), substantially exceeding rates reported in Western countries at 5–15% (*20,21,26*). Comparable data from other Asian countries remain limited, although a single-center study in South Korea reported a proportion of 14.2% (*27*). A previous scoping review found that no uniform diagnostic criteria for aspiration pneumonia exist, indicating that direct comparisons across studies may not be feasible (*28*). Similarly, recent multidisciplinary consensus recommendations have emphasized the complexity of geriatric dysphagia management and the need for standardized approaches to screening, diagnosis, and rehabilitation in older adults (*29*).

4.3. Comparison with existing literature

The effectiveness of pneumococcal vaccination against CAP and invasive pneumococcal disease in older populations has been established through multiple systematic reviews and meta-analyses (*5,30*). However,

none of these reviews specifically addressed aspiration pneumonia as an outcome, making the present scoping review the first to systematically examine this issue. Although our search identified no direct evidence, noteworthy findings have been reported in populations with a high risk of aspiration. Maruyama *et al.* (*31*) conducted a randomized controlled trial demonstrating that PPSV23 reduced all-cause pneumonia by 44.8% and pneumococcal pneumonia by 63.8% among Japanese nursing home residents. Nursing home populations inherently carry an elevated aspiration risk due to advanced age, poor functional status, and a high prevalence of neurological comorbidities. Given the prevalence of swallowing dysfunction of approximately 60% (*32*) among nursing home residents, a proportion of the pneumonia cases prevented by Maruyama *et al.* (*31*) may have included aspiration pneumonia.

Collectively, these findings suggest a potential vaccine benefit in populations with inherently elevated aspiration risk. However, because the study did not distinguish between aspiration and non-aspiration pneumonia, whether the observed vaccine efficacy extended specifically to aspiration pneumonia remains unknown, representing a key evidence gap.

4.4. Microbiological considerations

The theoretical basis for pneumococcal vaccination in the prevention of aspiration pneumonia warrants careful consideration of contemporary microbiological evidence. Although anaerobic bacteria have traditionally been regarded as the predominant pathogens in aspiration pneumonia, contemporary molecular studies using 16S rRNA gene analysis have challenged this view by demonstrating that anaerobes account for only approximately 6% of cases, whereas oral streptococci are the most frequently detected pathogens in patients with aspiration risk factors. Notably, *S. pneumoniae* detection rates were similar regardless of the aspiration risk status (13.0% *vs.* 13.7%) (*10*). A cohort study in the UK using culture and urinary antigen testing reported that, although *S. pneumoniae* detection rates were lower in patients with aspiration risk factors than in those without such risk factors (20.5% *vs.* 32.5%), *S. pneumoniae* remained one of the predominant pathogens in this population (*11*). These findings indicate that *S. pneumoniae* remains clinically relevant in patients at risk of aspiration, thereby providing a microbiological rationale for investigating pneumococcal vaccination as a potential preventive strategy.

4.5. Implications for clinical practice

Given the absence of direct evidence, clinical recommendations regarding pneumococcal vaccination specifically for the prevention of aspiration pneumonia cannot be established definitively. However, several considerations suggest that vaccination may be beneficial for patients at risk of aspiration, and clinicians may reasonably consider vaccination for these patients. First, these patients frequently have additional risk factors for pneumococcal disease, including advanced age, chronic comorbidities, and institutional residence, all of which are established indications for vaccination. Second, the inclusion of aspiration pneumonia within composite pneumonia outcomes showing vaccine benefits (*19*), combined with demonstrated vaccine efficacy in nursing home populations at high aspiration risk (*31*), supports its potential effectiveness in this population. Clinicians should continue to recommend pneumococcal vaccination to patients with aspiration risk who meet established indications while recognizing that aspiration-specific benefits remain unproven.

Several factors underscore the importance of addressing this evidence gap. Aspiration pneumonia is associated with high mortality rates, frequent recurrence, and significant healthcare burden, particularly in aging societies (*3,4*). Among available preventive interventions, pneumococcal vaccination is relatively easy to integrate into routine clinical practice. The absence of dedicated research on vaccine effectiveness for this high-burden condition represents a significant missed opportunity for evidence-based prevention. This gap also carries direct policy implications: Japan has implemented a national immunization program providing PPSV23 to adults aged ≥ 65 years since 2014, yet the effectiveness of this program against aspiration pneumonia—the predominant pneumonia pathophysiology in this demographic—has not been evaluated. In this sense, current national immunization programs targeting older adults have been implemented without direct evidence regarding their effectiveness against aspiration pneumonia, which was the predominant pneumonia phenotype in this demographic. This creates an implicit assumption of benefit against the very condition that represents the majority of pneumonia cases in the target population, an assumption that has never been empirically tested. Identifying this evidence gap is itself a clinically and policy-relevant finding: aspiration pneumonia constitutes the majority of pneumonia cases among the target population of pneumococcal immunization programs, yet no study has examined whether these programs confer protection against this predominant pathophysiology. Other Asian super-aged societies, including South Korea, face similar challenges in optimizing their pneumococcal immunization strategies for aging populations. Addressing this evidence gap would contribute to informed immunization policies in super-aged societies.

4.6. Implications for future research

This scoping review identified several priorities for future research. Prospective studies evaluating pneumococcal vaccination with aspiration pneumonia as a prespecified

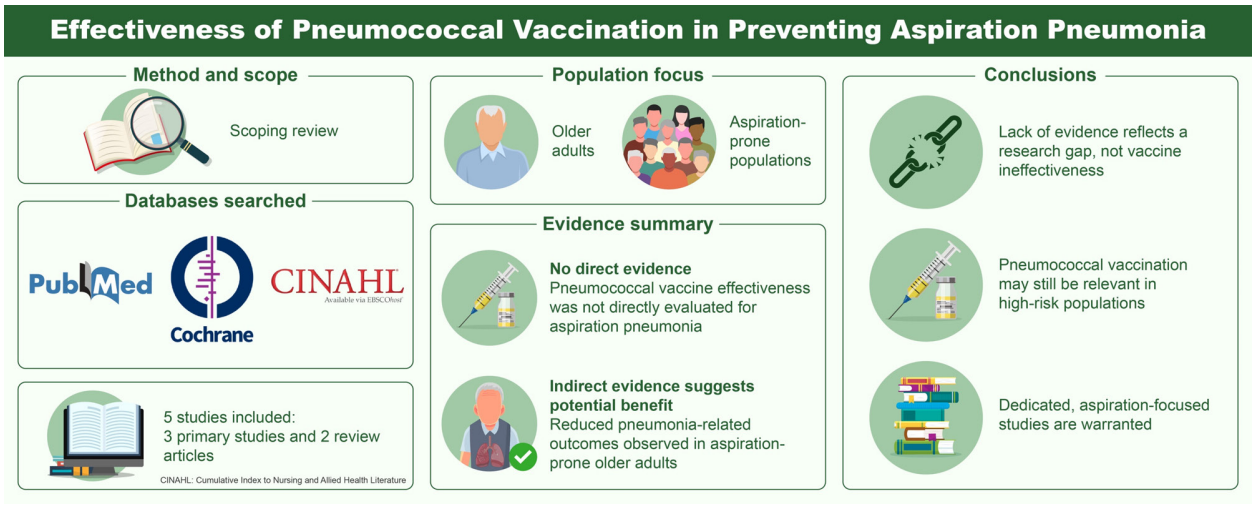

Figure 2. Graphical abstract summarizing the scope, methods, key findings, and conclusions of this scoping review on pneumococcal vaccination and aspiration pneumonia prevention in super-aged societies.

outcome are warranted. Microbiological studies determining the proportion of aspiration pneumonia cases caused by vaccine-covered serotypes may also help estimate the potential impact of vaccination. Additionally, secondary analyses of existing pneumonia vaccine trials stratifying outcomes according to aspiration risk factors may provide preliminary evidence.

4.7. Limitations

This scoping review has several limitations. First, the search strategy intentionally required explicit mention of aspiration pneumonia, dysphagia, or swallowing disorders to assess whether aspiration pneumonia has been recognized as a distinct evaluative outcome in vaccine research; however, this approach may have systematically excluded a substantial body of relevant literature from aspiration-prone populations without explicit outcome labeling. Studies conducted in populations inherently at high aspiration risk—such as nursing home residents, patients with stroke, or individuals with dementia—often do not explicitly label their populations or outcomes as "aspiration-related", even though these populations overlap significantly with those at risk for aspiration pneumonia. The trial by Maruyama *et al.* (*31*) exemplifies this limitation: despite enrolling nursing home residents with inherently elevated aspiration risk and demonstrating significant vaccine efficacy, our search did not capture this study because it did not include aspiration-related terms in its indexing. This suggests that indirect evidence regarding the effectiveness of pneumococcal vaccines in aspiration-prone populations may be considerably more extensive than that identified by our focused search. Second, the search was limited to English-language publications; searching regional databases such as Ichushi (Japan Medical Abstracts Society) may have identified additional relevant studies. Third, as a scoping review, a formal quality assessment of the included studies was not performed.

5. Conclusion

This scoping review revealed no direct evidence for pneumococcal vaccine effectiveness with aspiration pneumonia as a defined outcome, reflecting a lack of dedicated research rather than demonstrated ineffectiveness, as illustrated in Figure 2. Nevertheless, indirect evidence from related populations is consistent with the potential benefits for aspiration-prone patients. Given that Japan has invested substantial public health resources in pneumococcal vaccination programs for older adults, and other Asian super-aged societies are following suit, dedicated studies evaluating vaccine effectiveness against aspiration pneumonia are warranted to inform evidence-based immunization policies across the region. Secondary analyses of existing large-scale pneumonia vaccine trials, stratifying outcomes according to aspiration risk factors such as dysphagia, stroke history, or nursing home residence, represent a realistic and near-term approach to generating preliminary evidence while dedicated prospective studies are developed.

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