

Association between oral intake status and cough responsiveness in patients admitted to a convalescent rehabilitation ward: a retrospective cross-sectional study

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Abstract

Background:

Previous studies in acute stroke have reported that impaired cough responsiveness is associated with dysphagia and restricted oral intake. However, the association between oral intake status and cough-reflex impairment during the convalescent phase remains unclear. This study examined the association between oral intake status and cough-test results during the post-acute phase of rehabilitation.

Methods:

This retrospective cross-sectional study used medical records from a convalescent rehabilitation ward in Japan between September 2024 and August 2025. Oral intake status was grouped using the Functional Oral Intake Scale (FOIS) as levels 1–3, levels 4–6, and level 7. A positive cough test was defined as no cough within 60 s of inhaling 1% citric acid. Multivariable logistic regression treated the FOIS group as a categorical exposure (level 7 reference) and adjusted for age, sex, reason for hospitalization, and consciousness level. Cough latency among responders was examined in a secondary exploratory analysis.

Results:

Among 289 participants, 56 (19.4%) had a positive cough test. Positive-test proportions were 40.0% in FOIS levels 1–3, 21.0% in FOIS levels 4–6, and 13.2% in FOIS level 7 ($P = 0.007$). The overall adjusted association across the three FOIS categories was statistically significant ($P = 0.046$). The adjusted odds ratio (OR) for FOIS levels 1–3 versus level 7 was 4.45 (95% CI: 1.37, 14.49; $P = 0.013$), whereas the adjusted OR for FOIS levels 4–6 versus level 7 was 1.55 (95% CI: 0.75, 3.23; $P = 0.237$). In the secondary analysis, neither FOIS levels 1–3 nor levels 4–6 differed significantly from FOIS level 7 in cough latency.

Conclusions:

Patients with tube dependence had higher odds of a positive cough-test result than those with unrestricted oral intake, whereas no significant difference was observed in patients receiving a texture-modified diet. Even in convalescent rehabilitation settings, a more detailed swallowing assessment may be considered when clinically indicated in patients with marked oral intake restriction, particularly those with tube dependence.

Background

Dysphagia is associated with malnutrition, dehydration, aspiration pneumonia, prolonged hospitalization, and poorer functional outcomes [1, 2]. In convalescent rehabilitation wards, patients are admitted with a

range of conditions, including cerebrovascular and musculoskeletal diseases, and appropriate management of oral intake is an important component of rehabilitation. Post-stroke dysphagia is often most prominent in the acute phase and may improve substantially over subsequent weeks and months, although persistent dysphagia remains in a subset of patients [3, 4]. Texture-modified diets may provide lower energy and protein intake than regular diets; therefore, repeated assessment of swallowing and nutritional status is important during the post-acute rehabilitation phase [5, 6]. Because the swallowing function may improve during this phase, food texture and nutritional routes should be adjusted according to the patient's recovery to avoid unnecessary restrictions and facilitate progression toward oral intake [6, 7].

The cough reflex is an important airway-defense mechanism, and reduced cough responsiveness is associated with silent aspiration and aspiration pneumonia [2, 8]. Citric-acid cough testing has therefore been investigated as a bedside method for evaluating cough responsiveness [8, 9]. A recent prospective study of 395 critically ill patients with acute stroke reported that an absent or weakened cough response was associated with greater dysphagia severity, aspiration, and a lower likelihood of unrestricted oral intake [10]. However, that cohort represented a severely affected acute-stroke intensive-care population: 97% had undergone intubation and 63% had tube dependence [10]. In contrast, convalescent rehabilitation represents an important post-acute phase in which patients may transition from tube dependence toward oral intake as swallowing function recovers. Because acute and convalescent rehabilitation settings differ in patient characteristics and treatment goals, findings from acute-care populations may not necessarily be generalizable to patients undergoing convalescent rehabilitation. Moreover, convalescent rehabilitation wards include patients with a broad range of underlying conditions, such as cerebrovascular disease, musculoskeletal disease, and disuse syndrome [11, 12]. Clarifying the association between oral intake status and cough responsiveness during this phase may therefore be important for supporting effective rehabilitation while minimizing unnecessary restrictions on nutritional routes and the use of texture-modified diets.

This study aimed to characterize the association between oral intake status and cough-test results in patients admitted to a convalescent rehabilitation ward. Clarifying this association may contribute to more tailored swallowing rehabilitation during recovery. We hypothesized that patients with more restricted oral intake, including those with tube dependence, would be more likely to exhibit impaired cough responsiveness.

Methods

The aim of this study was to characterize the association between oral intake status and cough-test results in patients admitted to a convalescent rehabilitation ward.

Study design, setting, and participants

This retrospective cross-sectional study used medical records from a rehabilitation hospital in Chiba, Japan, with a total capacity of 295 beds. The hospital comprises convalescent rehabilitation wards, a community-based integrated care ward, and long-term care wards. The present analysis included patients admitted to the convalescent rehabilitation wards, where routine dental and dysphagia screening, including the cough test, was performed at admission. Admission data collected between September 2024 and August 2025 were used. Patients transferred to the ward after acute hospital care were eligible for inclusion. Convalescent rehabilitation wards in Japan commonly provide post-acute rehabilitation for cerebrovascular disease, musculoskeletal disease, and disuse syndrome; the latter refers to functional decline related to acute illness, surgery, or prolonged inactivity and broadly corresponds to hospital-associated deconditioning [11, 12]. This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Because cerebrovascular disease, musculoskeletal disease, and disuse syndrome are major target conditions in convalescent rehabilitation wards in Japan, the present study focused on patients admitted for these conditions. Patients were excluded if they were admitted for other reasons; used antitussive medications; used psychotropic medications; were unable to undergo the cough test because of a history of asthma, decreased oxygen saturation or respiratory distress, strong refusal, or tracheostomy; or had missing data (Fig. 1).

Ethical approval and informed consent

This study was approved by the Ethical Committee of the Faculty of Dentistry, Institute of Science Tokyo (approval number: S2025-048). The requirement for written informed consent was waived by the ethics committee because this study used retrospectively collected clinical data and involved no additional intervention. Study information was disclosed to participants through an opt-out procedure, and participants were given the opportunity to decline participation. This study was conducted in accordance with the Declaration of Helsinki, as revised by the 75th World Medical Association General Assembly in Helsinki, Finland, in October 2024.

Outcomes

The primary outcome was the cough-test result, assessed once by trained hospital staff at admission as part of routine dental and dysphagia screening. Using a mesh nebulizer (NE-U200; Omron Healthcare Co., Ltd., Kyoto, Japan), participants inhaled a 1% citric-acid solution, and cough responses were observed for 60 s, as described in previous cough-test protocols [8, 9, 13, 14]. The test was classified as negative when at least one cough was observed within 60 s and positive when no cough was observed within 60 s. This outcome was interpreted as a measure of cough responsiveness rather than as direct evidence of aspiration. Cough latency was defined as the time from the start of citric-acid inhalation to the first cough response and was recorded among participants with a negative cough-test result [13, 14].

Explanatory variables

Exposure

The Functional Oral Intake Scale (FOIS) was used to assess oral intake status. FOIS levels 1–3 represent tube dependence: level 1, tube dependence without oral intake; level 2, tube dependence with minimal or inconsistent oral intake; level 3, tube dependence with consistent oral intake of food or liquid; level 4, total oral intake of a single consistency; level 5, total oral intake of multiple consistencies requiring special preparation or compensatory strategies; level 6, total oral intake without special preparation but with specific food limitations; and level 7, total oral intake with no restrictions [15].

Covariates

Covariates included age, sex, reason for hospitalization, and Japan Coma Scale (JCS) score at admission. Age and sex were obtained from medical records. Reason for hospitalization was classified into three categories: cerebrovascular disease, musculoskeletal disease, and disuse syndrome. Level of consciousness was assessed using the JCS, with higher scores indicating more severe disturbance of consciousness [16].

Statistical analysis

For the primary analysis, the seven FOIS levels were grouped into three clinically interpretable categories: levels 1–3, representing tube dependence; levels 4–6, representing total oral intake with a texture-modified diet and/or compensatory strategies; and level 7, representing unrestricted oral intake [15]. Baseline characteristics were compared across these three FOIS groups (Table 1). Continuous variables were analyzed using the Kruskal–Wallis test, and categorical variables were analyzed using Pearson’s Chi-square test.

Table 1
Patient characteristics.

Variable	FOIS 1–3 (n = 25)	FOIS 4–6 (n = 143)	FOIS 7 (n = 121)	P-value	Total (N = 289)
Age, years	81.64 ± 9.67	80.57 ± 9.69	75.32 ± 13.46	0.003*	78.46 ± 11.69
Sex, n (%)				0.100	
Male	6 (24.0)	66 (46.2)	48 (39.7)		120 (41.5)
Female	19 (76.0)	77 (53.8)	73 (60.3)		169 (58.5)
BMI, kg/m ²	20.09 ± 3.92	20.46 ± 3.79	22.20 ± 4.02	< 0.001*	21.16 ± 3.98
Reason for hospitalization, n (%)				< 0.001*	
Cerebrovascular disease	16 (64.0)	50 (35.0)	23 (19.0)		89 (30.8)
Musculoskeletal disease	2 (8.0)	58 (40.6)	71 (58.7)		131 (45.3)
Disuse syndrome	7 (28.0)	35 (24.5)	27 (22.3)		69 (23.9)
JCS	2.16 ± 2.27	0.50 ± 1.20	0.09 ± 0.47	< 0.001*	0.47 ± 1.24
Smoking history, n (%)				0.055	
Yes	4 (16.0)	59 (41.3)	46 (38.0)		109 (37.7)
No	21 (84.0)	84 (58.7)	75 (62.0)		180 (62.3)
Continuous variables are presented as mean±standard deviation unless otherwise indicated.					
*Kruskal–Wallis test. *Pearson’s Chi-square test. *P < 0.05 was considered statistically significant.					

Abbreviations: BMI, body mass index; FOIS, Functional Oral Intake Scale; JCS, Japan Coma Scale.

Cough-test results were compared across the three FOIS categories (Table 2). Because the cough-test result was a binary variable, the proportion of participants with a positive cough test was calculated for each FOIS category, and group differences were examined using Pearson’s Chi-square test.

Table 2

Distribution of cough-test results and reasons for hospitalization according to FOIS categories.

FOIS category / Reason for hospitalization	Cough-test negative	Cough-test positive	Total
FOIS levels 1–3	15 (60.0)	10 (40.0)	25
Cerebrovascular disease	9	7	16
Musculoskeletal disease	2	0	2
Disuse syndrome	4	3	7
FOIS levels 4–6	113 (79.0)	30 (21.0)	143
Cerebrovascular disease	37	13	50
Musculoskeletal disease	47	11	58
Disuse syndrome	29	6	35
FOIS level 7	105 (86.8)	16 (13.2)	121
Cerebrovascular disease	18	5	23
Musculoskeletal disease	63	8	71
Disuse syndrome	24	3	27
Total	233 (80.6)	56 (19.4)	289
Overall P = 0.007 (Pearson's Chi-square test).			
Data are presented as n (%) for FOIS category rows and as n for reason-for-hospitalization subrows. Percentages in the FOIS category rows were calculated within each FOIS category. The <i>P</i> -value represents the overall association between FOIS category and cough-test result using Pearson's Chi-square test.			

Abbreviations: FOIS, Functional Oral Intake Scale.

Univariable and multivariable binary logistic regression analyses were performed to examine the association between oral intake status and a positive cough-test result (Table 3). The dependent variable was coded as 0 for a negative cough-test result and 1 for a positive cough-test result. The three FOIS groups defined above were treated as a categorical exposure in the primary analysis. Two indicator variables were created, with FOIS level 7 used as the reference category. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were estimated for each FOIS group, with FOIS level 7 as the reference category. Age, sex, reason for hospitalization, and JCS were entered simultaneously as covariates using the forced-entry method. Sex was coded as 0 for female and 1 for male. Reason for hospitalization was treated as a categorical variable, with cerebrovascular disease used as the reference category. Results are presented as odds ratios (ORs) with 95% CIs.

Table 3

Univariable and multivariable logistic regression analyses of factors associated with a positive cough-test result.

Variable	Univariable OR	95% CI	P-value	Adjusted OR	95% CI	P-value
FOIS, overall	—	—	0.010*	—	—	0.046*
FOIS levels 1–3	4.38	1.68, 11.40	0.003*	4.45	1.37, 14.49	0.013*
FOIS levels 4–6	1.74	0.90, 3.38	0.100	1.55	0.75, 3.23	0.237
FOIS level 7	Reference	—	—	Reference	—	—
Age, per year	1.00	0.97, 1.02	0.684	1.00	0.97, 1.02	0.790
Sex						
Male	2.64	1.45, 4.81	0.001*	2.92	1.53, 5.60	0.001*
Female	Reference	—	—	Reference	—	—
Reason for hospitalization						
Musculoskeletal disease	0.43	0.22, 0.85	0.015*	0.71	0.33, 1.50	0.367
Disuse syndrome	0.54	0.25, 1.17	0.118	0.66	0.29, 1.50	0.323
Cerebrovascular disease	Reference	—	—	Reference	—	—
JCS	1.21	0.98, 1.48	0.071	1.07	0.84, 1.36	0.604
Overall Wald tests in the multivariable model: FOIS group, $\chi^2=6.141$, $df = 2$, $P = 0.046$; reason for hospitalization, $\chi^2=1.249$, $df = 2$, $P = 0.535$. The multivariable model included FOIS group, age, sex, reason for hospitalization, and JCS. FOIS level 7, female sex, and cerebrovascular disease were used as reference categories.						

Abbreviations: CI, confidence interval; FOIS, Functional Oral Intake Scale; JCS, Japan Coma Scale; OR, odds ratio.

As a secondary exploratory analysis, multiple linear regression was performed among participants with a negative cough-test result, defined as those who coughed within 60 s (Table 4). Cough latency was used as the dependent variable, and the three FOIS categories, age, sex, reason for hospitalization, and JCS were entered simultaneously. FOIS category and reason for hospitalization were treated as categorical variables, with FOIS level 7 and cerebrovascular disease used as the respective reference categories.

Participants with a positive cough-test result were excluded from this analysis because no cough was observed within the 60-s observation period. All statistical analyses were performed using IBM SPSS Statistics version 31 J (IBM Japan, Tokyo, Japan). Statistical significance was set at a two-sided *P*-value of < 0.05.

Table 4
Multiple linear regression of factors associated with latency to first cough.

Variable	B	95% CI	SE	P-value
FOIS category				
FOIS levels 1–3	1.828	–7.02, 10.67	4.489	0.684
FOIS levels 4–6	–2.336	–6.45, 1.78	2.087	0.264
FOIS level 7	Reference	—	—	—
Age, years	–0.042	–0.21, 0.13	0.086	0.627
Sex				
Male	5.196	1.24, 9.16	2.009	0.010
Female	Reference	—	—	—
Reason for hospitalization				
Musculoskeletal disease	1.258	–3.53, 6.04	2.427	0.605
Disuse syndrome	1.966	–3.36, 7.29	2.700	0.467
Cerebrovascular disease	Reference	—	—	—
JCS	2.190	0.38, 4.00	0.920	0.018
Model: n = 233; $R^2=0.063$; adjusted $R^2=0.034$; $F(7, 225) = 2.176$; $P = 0.037$.				
B represents the unstandardized regression coefficient. FOIS level 7, female sex, and cerebrovascular disease were used as the reference categories.				

Abbreviations: CI, confidence interval; FOIS, Functional Oral Intake Scale; JCS, Japan Coma Scale; SE, standard error.

Results

Participant flow

Medical records of 687 patients admitted during the study period were screened. Of these, 398 were excluded for the following reasons: admission for reasons other than cerebrovascular disease, musculoskeletal disease, or disuse syndrome (n = 269); use of antitussive medications (n = 31); use of

psychotropic medications ($n = 41$); inability to undergo the cough test ($n = 34$); and missing data ($n = 23$). Reasons for inability to undergo the cough test were a history of asthma ($n = 21$), decreased oxygen saturation or respiratory distress ($n = 9$), strong refusal ($n = 1$), and tracheostomy ($n = 3$). Finally, 289 patients were included in the analysis: 120 men and 169 women, with a mean age of 78.46 ± 11.69 years (Fig. 1).

Baseline characteristics

Participant characteristics according to oral intake status are shown in Table 1. The 289 participants were classified into three FOIS groups: levels 1–3 ($n = 25$), levels 4–6 ($n = 143$), and level 7 ($n = 121$).

Significant between-group differences were observed in age ($P = 0.003$), BMI ($P < 0.001$), reason for hospitalization ($P < 0.001$), and JCS score ($P < 0.001$). The distribution of reasons for hospitalization differed significantly among the three FOIS groups. In the FOIS levels 1–3 group, cerebrovascular disease was the most common reason for hospitalization (16/25 [64.0%]); in the FOIS level 7 group, musculoskeletal disease was the most common (71/121 [58.7%]). No significant between-group differences were observed in sex ($P = 0.100$) or smoking history ($P = 0.055$).

Cough-test results by oral intake status

Cough-test results according to the FOIS categories are shown in Table 2. Among the 289 participants, 233 (80.6%) had a negative cough-test result and 56 (19.4%) had a positive cough-test result. The proportion of positive cough-test results differed across FOIS categories ($P = 0.007$): 40.0% (10/25) in FOIS levels 1–3, 21.0% (30/143) in FOIS levels 4–6, and 13.2% (16/121) in FOIS level 7. Among the 10 patients with FOIS levels 1–3 and a positive cough-test result, 7 (70.0%) had cerebrovascular disease, 3 (30.0%) had disuse syndrome, and none had musculoskeletal disease.

Association between oral intake status and cough-test results

Table 3 presents the univariable and multivariable logistic regression analyses, with FOIS level 7 as the reference category. In both the univariable and multivariable analyses, FOIS levels 1–3 were significantly associated with higher odds of a positive cough-test result than FOIS level 7. In the univariable analysis, the OR for FOIS levels 1–3 versus FOIS level 7 was 4.38 (95% CI: 1.68, 11.40; $P = 0.003$), whereas that for FOIS levels 4–6 versus FOIS level 7 was 1.74 (95% CI: 0.90, 3.38; $P = 0.100$). After adjustment, the association for FOIS levels 1–3 remained significant, with an adjusted OR of 4.45 (95% CI: 1.37, 14.49; $P = 0.013$), whereas the association for FOIS levels 4–6 remained nonsignificant (adjusted OR, 1.55; 95% CI: 0.75, 3.23; $P = 0.237$). The overall association between the three FOIS categories and a positive cough-test result was statistically significant in the multivariable model ($P = 0.046$). Estimates for the other covariates are shown in Table 3.

Latency to first cough analysis

Table 4 presents the results of the secondary exploratory multiple linear regression analysis of factors associated with latency to first cough among participants with a negative cough-test result. The overall model was statistically significant ($F(7, 225) = 2.176, P = 0.037$) and explained a small proportion of the variance in cough latency (adjusted $R^2=0.034$).

In the exploratory linear regression analysis, neither FOIS levels 1–3 nor FOIS levels 4–6 differed significantly from FOIS level 7 in cough latency. Compared with FOIS level 7, FOIS levels 1–3 had a regression coefficient of 1.828 s (95% CI: –7.02 to 10.67; $P = 0.684$), whereas FOIS levels 4–6 had a regression coefficient of –2.336 s (95% CI: –6.45 to 1.78; $P = 0.264$). Male sex ($B = 5.196$; 95% CI: 1.24 to 9.16; $P = 0.010$) and higher JCS score ($B = 2.190$; 95% CI: 0.38 to 4.00; $P = 0.018$) had coefficients consistent with longer latency to first cough. As this was a secondary exploratory analysis and the model explained little variance, these findings should be interpreted cautiously.

Discussion

This study examined the association between oral intake status and cough-test results in patients admitted to a convalescent rehabilitation ward. Positive cough-test results were observed in 40.0% of patients with FOIS levels 1–3, 21.0% of those with FOIS levels 4–6, and 13.2% of those with FOIS level 7. The overall adjusted association across the three FOIS groups was statistically significant ($P = 0.046$), and patients with FOIS levels 1–3 had significantly higher odds of a positive cough-test result than those with FOIS level 7 (adjusted OR, 4.45; 95% CI: 1.37, 14.49; $P = 0.013$). In contrast, no significant difference was observed between FOIS levels 4–6 and FOIS level 7 (adjusted OR, 1.55; 95% CI: 0.75, 3.23; $P = 0.237$). These findings suggest that patients with tube dependence are more likely to have impaired cough responsiveness than those with unrestricted oral intake, whereas patients receiving a texture-modified diet did not differ significantly from those with unrestricted oral intake. In the secondary exploratory analysis, neither FOIS levels 1–3 nor levels 4–6 differed significantly from FOIS level 7 in cough latency, whereas male sex and higher JCS score were associated with longer latency.

The findings of the present study are consistent with those of Jung et al. [10], who reported an association between impaired cough responsiveness and swallowing impairment in critically ill patients with acute stroke admitted to an intensive care unit. However, the characteristics of the study populations differed substantially. Whereas their cohort consisted exclusively of patients with acute stroke, 97% of whom had undergone intubation and 63% of whom had tube dependence, the present cohort comprised patients admitted for cerebrovascular disease (30.8%), musculoskeletal disease (45.3%), and disuse syndrome (23.9%) during the post-acute rehabilitation phase. In addition, 8.7% of patients in the present cohort had tube dependence, whereas the majority were receiving some form of oral intake. Thus, the present findings extend previous observations from critically ill patients with acute stroke to a more heterogeneous population undergoing convalescent rehabilitation. The difference in phase of care is also clinically important even when considering stroke alone. In a prospective cohort of 427 patients with acute stroke, dysphagia was present in 55% at initial assessment and 37% at discharge, and only 5% had tube dependence at 6 months [17]. In particular during the recovery phase,

patients may transition from tube dependence to oral intake; therefore, information on cough responsiveness may provide useful complementary information when planning dysphagia rehabilitation and considering the progression of oral intake. Despite marked differences in patient characteristics and stage of recovery, our findings showed a pattern similar to that reported in previous studies. Patients with FOIS levels 1–3, who had tube dependence, had a higher prevalence of positive cough-test results, and FOIS levels 1–3 were associated with significantly higher odds of a positive cough-test result than FOIS level 7 after adjustment for covariates (adjusted OR, 4.45; 95% CI: 1.37, 14.49; $P = 0.013$). Notably, positive cough-test results were also observed in a substantial proportion of patients with oral intake, including those with FOIS levels 4–6 and FOIS level 7. Among the 10 patients with FOIS levels 1–3 who had a positive cough-test result, seven had cerebrovascular disease and three had disuse syndrome; none had musculoskeletal disease (Table 2). Although the number of patients was small, this finding suggests that impaired cough responsiveness associated with severe oral intake restriction may not be confined to patients with stroke and highlights the need to extend investigation to other patient populations in convalescent rehabilitation settings. In addition, male sex was independently associated with a positive cough-test result (adjusted OR, 2.92; 95% CI: 1.53, 5.60; $P = 0.001$), which is consistent with previous reports of sex-related differences in cough reflex sensitivity, with lower cough sensitivity in men than in women [18]. These findings suggest that, in the convalescent rehabilitation setting, impaired cough responsiveness may warrant consideration during dysphagia rehabilitation, particularly in male patients and those with tube dependence.

One possible mechanism underlying the association between tube dependence and impaired cough responsiveness is reduced oral and pharyngolaryngeal sensory input associated with limited oral intake, which may alter swallowing and airway-protective reflexes [19–22]. Sensory input from the pharynx and larynx plays an important role in swallowing and airway protection, and impaired laryngeal sensation has been associated with compromised airway-protective function in patients with dysphagia [23]. Patients with tube dependence may receive less pharyngolaryngeal sensory stimulation from food and liquid than those who maintain oral intake. In contrast, patients with FOIS levels 4–6 continue to receive all nutrition orally despite a texture-modified diet or the use of compensatory strategies. In the present study, the adjusted odds of a positive cough-test result did not differ significantly between FOIS levels 4–6 and FOIS level 7.

This study has several limitations. First, the cough test assessed cough responsiveness, whereas aspiration, silent aspiration, and swallowing safety were not directly evaluated using instrumental swallowing assessment; therefore, the present data cannot establish diagnostic accuracy for aspiration. Second, because this was a cross-sectional study, temporal sequence and causality cannot be determined. Third, this was a single-center study, which limits generalizability. In addition, only 56 of 289 participants had a positive cough-test result, only 25 were classified as FOIS levels 1–3, and the FOIS groups were markedly unequal in size; these data characteristics may have reduced the precision and stability of the multivariable estimates, particularly for the most restricted group. Indeed, the adjusted OR for FOIS levels 1–3 versus FOIS level 7 had a wide 95% CI (1.37, 14.49), indicating considerable uncertainty in the magnitude of the association. Nevertheless, the association remained statistically

significant after adjustment, and the direction and magnitude of the estimate were broadly consistent with those observed in the univariable analysis. Therefore, although the precision of the estimate was limited, the present findings provide clinically relevant preliminary evidence and warrant confirmation in larger-scale studies. Finally, detailed disease-specific severity measures and other potential confounders were not available, leaving the possibility of residual confounding.

Despite these limitations, the finding that patients with tube dependence were more likely to exhibit impaired cough responsiveness suggests that this clinical pattern may remain relevant during the post-acute rehabilitation phase. When considering the initiation or advancement of oral intake during dysphagia rehabilitation in patients with tube dependence, bedside swallowing screening and clinical assessment based on overt signs such as coughing or choking, including the Modified Water Swallowing Test (MWST) and Food Test (FT), may provide useful initial information [24, 25]. In addition, instrumental swallowing assessment using videofluoroscopy or flexible endoscopic evaluation of swallowing may be valuable to directly evaluate aspiration [26]. Cough responsiveness may change over time during recovery. In patients with stroke, the citric acid cough-reflex threshold has been reported to decrease during the first 4 weeks after stroke, suggesting partial recovery of cough-reflex responsiveness over time [27]. Although evidence remains limited, repeated assessment of cough responsiveness during rehabilitation may therefore provide clinically relevant information on changes in airway-protective function. Therefore, prospective multicenter studies incorporating serial cough testing, instrumental swallowing assessment, and clinical outcomes may be warranted to further clarify how changes in cough responsiveness relate to swallowing physiology and subsequent complications.

Conclusions

The overall adjusted association across the three FOIS categories was statistically significant ($P = 0.046$), and patients with FOIS levels 1–3 had significantly higher odds of a positive cough-test result than those with unrestricted oral intake (FOIS level 7; adjusted OR, 4.45; 95% CI: 1.37, 14.49; $P = 0.013$). These findings suggest that patients with tube dependence may be more likely to exhibit impaired cough responsiveness during the post-acute rehabilitation phase, whereas patients receiving a texture-modified diet did not differ significantly from those with unrestricted oral intake. Further studies involving larger rehabilitation cohorts are needed to clarify the association between oral intake status and impaired cough responsiveness.

Abbreviations

BMI, body mass index; CI, confidence interval; FOIS, Functional Oral Intake Scale; FT, Food Test; JCS, Japan Coma Scale; MWST, Modified Water Swallowing Test; OR, odds ratio.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethical Committee of the Faculty of Dentistry, Institute of Science Tokyo (approval number: S2025-048). The requirement for written informed consent was waived by the ethics committee because this retrospective study used routinely collected clinical data and involved no additional intervention. Study information was disclosed through an opt-out procedure, and participants were given the opportunity to decline participation. This study was conducted in accordance with the Declaration of Helsinki, as revised by the 75th World Medical Association General Assembly in Helsinki, Finland, in October 2024.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available because they contain potentially sensitive patient information, but de-identified data may be available from the corresponding author on reasonable request and with permission from the relevant ethics committee.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MM contributed to the conception, design, data acquisition, analysis, and interpretation of the study and drafted and critically revised the manuscript. KY (Kohei Yamaguchi) and RY contributed to the conception, design, and interpretation of the study and critically revised the manuscript. TH, AK, and NI contributed to the conception, design, and data acquisition and critically revised the manuscript. KY (Kanako Yoshimi), KN, and HT contributed to the conception, design, and interpretation of the study and critically revised the manuscript. All authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

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Figures

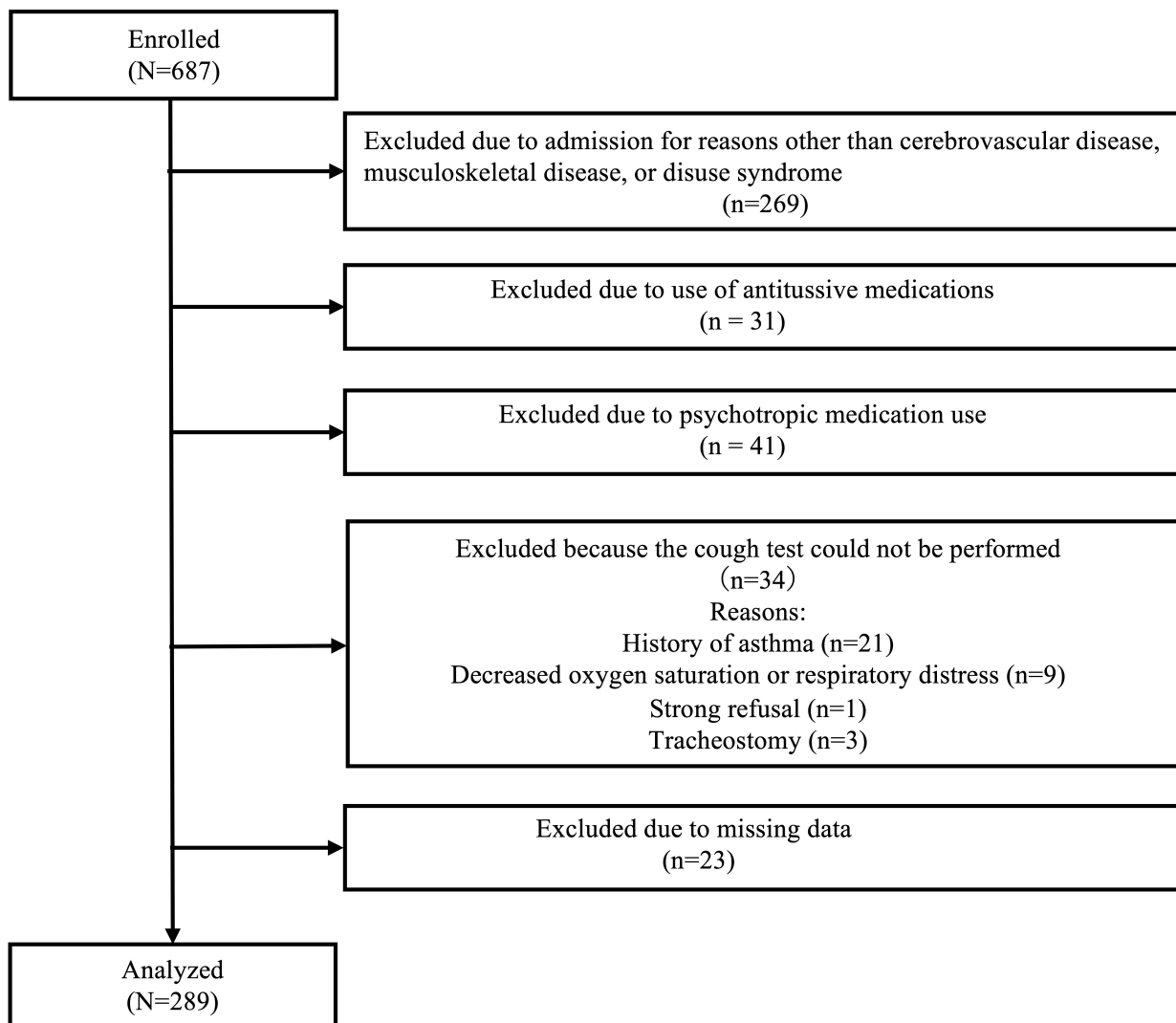


Figure 1

Flow diagram of participant selection.

Medical records of 687 patients were screened. A total of 398 were excluded because of admission for reasons other than cerebrovascular disease, musculoskeletal disease, or disuse syndrome (n=269), use of antitussive medications (n=31), use of psychotropic medications (n=41), inability to undergo the cough test (n=34), or missing data (n=23). Finally, 289 patients were included in the analysis.