ORIGINAL ARTICLE
(CC BY-SA)

UDC: 616.32-008.1-053.9
DOI: https://doi.org/10.2298/VSP251019047Y

Head flexion, trunk sway, and self-reported strategies in older adults screening positive for oropharyngeal dysphagia: an exploratory mixed-methods study

Fleksija glave, njihanje trupa i samoprijavljene strategije kod starijih osoba sa pozitivnim skriningom na orofaringealnu disfagiju: istraživačka studija mešovitih metoda

Ziya Yildiz*, Ahmet Ali Süzen†

Isparta University of Applied Sciences, *Uluborlu Vocational School, †Department of Computer Engineering, Isparta, Türkiye

Abstract

Background/Aim. Older adults with oropharyngeal dysphagia (OD) residing in nursing homes without clinical guidance may spontaneously adopt compensatory strategies through adjustments in eating and swallowing. However, evidence regarding the spontaneous emergence of head flexion (HF) and postural adaptations remains limited. The aim of the study was to investigate adaptive head posture and trunk sway (TS) during swallowing in older adults screening positive for OD (spOD). **Methods**. Based on the presence of a swallowing disorder determined by the 100 mL water swallow test, a total of 45 older adults were classified into two groups: a group with spOD (spOD group) and a group without spOD (non-spOD group). Head posture was assessed using a smartphone-based accelerometer, and TS was evaluated with a Swaymeter. Data were analyzed using image processing techniques. Group comparisons were performed using multivariate analysis of covariance – MANCOVA with Bonferroni correction, followed by a confirmatory multivariable linear regression. Semi-structured interviews were conducted with the spOD group to explore their recognition of spontaneous strategies. **Results**. The spOD group (n = 21) showed significantly greater maximum HF during swallowing compared to the non-spOD group (n = 24) (p = 0.0002). No significant group differences were observed in TS parameters (p > 0.00625). Linear regression indicated a positive association between spOD and maximum HF: B = 13.46, 95% confidence interval: 6.50–20.41, p < 0.001. In interviews, the participants reported various conscious strategies (e.g., small bites, water use, breath-holding), but none mentioned HF or trunk sway. **Conclusion**. Despite the HF and TS results obtained in older individuals, this cross-sectional study cannot determine whether HF serves a compensatory function or is merely associated with OD. Therefore, no clinical recommendations can be drawn from these findings.

Keywords:
aged; deglutition disorders; head movements; nursing home residents; oropharynx.

Apstrakt

Uvod/Cilj. Starije osobe sa orofaringealnom disfagijom (OD), koje borave u domovima za stare bez kliničkog vođstva, mogu spontano, kroz prilagođavanje ishrani i gutanju, usvojiti kompenzacione strategije. Međutim, ograničeni su dokazi o spontanoj pojavi fleksije glave (*head flexion* – HF) i posturalnih adaptacija. Cilj rada bio je da se kod starijih osoba sa pozitivnim skriningom na OD (*screening positive for OD* – spOD) istraži adaptivni položaj glave i njihanje trupa (*trunk sway* – TS) tokom gutanja. **Metode.** Na osnovu prisustva poremećaja gutanja, utvrđenog testom gutanja 100 mL vode, ukupno 45 starijih osoba klasifikovano je u dve grupe: grupa spOD i skrining negativnu grupu (*non*-spOD grupa). Položaj glave procenjivan je pomoću akcelerometra na „pametnom“ telefonu, dok je TS evaluiran primenom Swaymeter-a. Podaci su analizirani korišćenjem tehnika obrade slika. Upoređivanje rezultata grupa izvršeno je korišćenjem multivarijantne analize kovarijanse (*multivariate analysis of covariance* – MANCOVA), sa Bonferonijevom korekcijom, nakon čega je sprovedena potvrdna multivarijabilna linearna regresija. Da bi se istražilo prepoznavanje spontanih strategija, sprovedeni su polustrukturalni intervjui sa ispitanicima spOD grupe. **Rezultati.** Grupa spOD (n = 21) pokazala je značajno veću maksimalnu HF tokom gutanja u poređenju sa *non*-spOD grupom (n = 24) (p = 0,0002). Nisu primećene značajne razlike između grupa u parametrima TS

Correspondence to: Ahmet Ali Süzen, Isparta University of Applied Sciences, Department of Computer Engineering, 32 050, Isparta, Türkiye. E-mail: ahmetsuzen@isparta.edu.tr

(p > 0,00625). Linearnom regresijom pokazana je pozitivna veza između spOD i maksimalne HF: B = 13,46, 95% *confidence interval*: 6,50–20,41, p < 0,001. Učesnici su u intervjuima prijavili različite svesne strategije (npr. mali zalogaji, upotreba vode, zadržavanje daha), ali niko nije pomenuo HF ili TS. **Zaključak**. Uprkos rezultatima za HF i TS kod starijih osoba, ovom studijom preseka ne može se utvrditi da li je HF kompenzatorna funkcija ili je samo povezana sa OD. Shodno tome, na osnovu ovih nalaza se ne mogu doneti kliničke preporuke.

Ključne reči:
stare osobe; gutanje, poremećaji; glava, pokreti; starački domovi, stanari; orofarinks.

Introduction

Oropharyngeal dysphagia (OD), which impairs the safety and efficiency of swallowing from the oral cavity to the oesophagus, is common among older adults in nursing homes and is associated with a poor prognosis [1]. OD is common in older adults, particularly after stroke and in neurological diseases such as Parkinson's and Alzheimer's disease [2]. However, in healthy older adults, age-related physiological changes in swallowing can occur and may contribute to OD [3]. In older adults, OD can lead to serious complications, including dehydration, malnutrition, aspiration pneumonia, hospitalization, and even death [4]. It is also strongly associated with poor quality of life, social isolation, anxiety, and depression [5]. Despite these severe consequences, OD often goes unrecognized in older adults living in nursing homes. This is largely because individuals tend to perceive swallowing difficulties as a natural part of ageing and therefore do not report them to healthcare professionals. Moreover, clinicians frequently fail to detect OD, which leads to an underestimation of its true prevalence [6]. Although prevalence rates vary, a recent review reported that OD affects approximately 52.2% of nursing home residents [95% confidence interval (CI): 33.3–67.2] [7].

Clinicians often recommend standard compensatory strategies such as dietary adjustments, oral hygiene, postural modification and swallowing manoeuvres to manage OD [8, 9]. Because follow-up care for dysphagia is often inadequate, and rehabilitation programs are not fully tailored to individual needs, many people with OD attempt to manage the condition independently [10]. Qualitative studies report some techniques that elderly residents of nursing homes develop spontaneously before seeking clinical support when they have difficulty swallowing. These methods include slowing down eating, taking small bites, tapping the chest or back during choking, drinking water after each bite, and maintaining oral hygiene [4]. Similarly, community-dwelling older people often use diet-based strategies to cope with OD, such as avoiding hard-to-swallow foods, rinsing the mouth with water, or softening hard foods with warm liquids [11]. Some of these self-reported strategies–such as maintaining oral hygiene, taking small bites, and swallowing with water–partially align with the compensatory methods recommended by clinicians. Although head flexion (HF) [12] and other postural compensation (e.g., upright sitting, head rotation) [8] are frequently recommended in clinical settings and have been reported as experiential practices among individuals with paralysis [13], there is no clear evidence that older adults with OD in nursing homes adopt these strategies on their own.

This study aimed to evaluate spontaneous head and trunk movement patterns during water swallowing in older adults screening positive for OD (spOD) compared to those without spOD.

Methods

Study design and ethical approval

This study employed a cross-sectional and mixed-method explanatory sequential design. Qualitative data were used to enrich the interpretation of quantitative findings and to explore participants' lived experiences [14].

In the first stage of the study, demographic information, dependence levels, and cognitive status of the participants were recorded. Participants were then classified into two groups based on the presence or absence of spOD, as determined by the 100 mL water swallow test. Each participant was instructed to swallow 10 mL of thickened water, during which head posture (HP) and trunk sway (TS) were assessed. TS was measured using a Swaymeter, and HP was evaluated using an accelerometer. Subsequently, qualitative data were gathered through semi-structured interviews.

Ethical approval for the study was obtained from the Ethics Committee of Isparta University of Applied Sciences, Isparta, Türkiye (No. 02, from April 05, 2024). The study was conducted in accordance with the principles of the Declaration of Helsinki, and written informed consent was obtained from all participants.

Participants

A power analysis was conducted to determine the required sample size for the study. Based on the study by Nagura et al. [12], the sample size was calculated using GPower 3.1 software. Assuming $\alpha = 0.05$, power $(1-\beta)$ of 0.95, and an effect size of 1.15, the minimum sample size was estimated to be n = 18 participants *per* group. The inclusion criteria for the study were as follows: patients aged 65–80 years; those residing in a nursing home for at least 1 year; those receiving full oral nutrition; those with no cognitive impairment; patients with no prior clinical support for a swallowing disorder; and those volunteering to participate in the study. The study's exclusion criteria included the following: a diagnosed neurological disorder; any orthopedic limitation affecting head/neck mobility or sitting posture; a history of oncological disease or treatment; a history of head and neck surgery; and dependence in activities of daily living.

Participants were recruited from three nursing homes located in Isparta Province, southern Türkiye. Based on the inclusion and exclusion criteria, 45 out of 171 older adult residents were eligible for the study. Reasons for their exclusion were age over 80 years (n = 38), residence less than 1 year (n = 7), inability to meet nutritional needs through oral intake (n = 19), cognitive impairment (n = 24), history of neurological disease (n = 16), prior neck surgery (n = 2), dependence in daily living activities (n = 5), and current or past oncological treatment (n = 15).

Evaluation of cognitive, functional status, and swallowing function

Demographic information, existing chronic conditions, surgical history, medication use, smoking and alcohol habits, dietary habits, and pulmonary infections in the past year were evaluated. Participants scoring below the cut-off on the Mini-Mental State Examination and the Barthel index [15], which assess cognitive and functional status, were excluded.

The 100 mL water swallow test is a practical and widely used screening method to assess swallowing function in older adults with spOD, with a reported sensitivity of 85.5% and specificity of 50% [16]. However, the test is a screening instrument, not a diagnostic gold standard [17]. Water was chosen because it is a standardized liquid bolus and, compared to thicker consistencies, it places greater demands on the swallowing mechanism, making it a more sensitive test for revealing OD risk in older adults [18]. No instrumental confirmation (Videofluoroscopic Swallow Study/Flexible Endoscopic Evaluation of Swallowing – VFSS/FEES) was performed. This test provides an objective measure of an individual's liquid-swallowing capacity and is clinically relevant for identifying spOD risk. Participants were asked to drink 100 mL of water as quickly as possible while seated upright. The test was discontinued if any signs of choking, coughing, suspected aspiration, or change in voice quality were observed. Swallowing speed was calculated by dividing the volume of water consumed (mL) by the elapsed time (sec), expressed as mL/sec. Participants exhibiting a swallowing speed below 10 mL/sec were classified as spOD [17].

Swaymeter-based sitting balance assessment and image processing

The Swaymeter test is a validated and reliable method for measuring postural sway in the horizontal plane, particularly in older adults [19]. One end of the Swaymeter rod was secured with a belt at the participants' axillary level while they were seated on a backless, armless chair. The other end, fitted with a ballpoint pen, was placed in contact with a sheet of paper marked with guidelines spaced 0.5 cm apart. Participants were instructed to hold 10 mL of water thickened to 1% consistency (Nestle® ThickenUp® Clear, Vevey, Switzerland) in their mouths and then swallow it as they normally would. At the onset of swallowing, the pen was brought into contact with the paper and lifted immediately after the swallow was completed. TS was recorded in four directions: right-anterior, right-posterior, left-anterior, and left-posterior (Figure 1). The number of swallows was also recorded by observing laryngeal elevation.

The obtained data were analyzed using a visual processing model in four regions (anterior-right, anterior-left, posterior-right, posterior-left) in terms of the number of pixels and the distance of the furthest pixel from the center point. In this study, Swaymeter analysis evaluated not only the maximum sway distances [19] but also pixel density, allowing assessment of the directional persistence and duration of TS. An image processing algorithm was developed using digital images captured with a camera (Figure 2a) to quantitatively evaluate traces recorded on paper with the Swaymeter. In this study, the Open Computer Vision Library – OpenCV and Numerical Python – NumPy were used for the automatic detection and quantitative analysis of objects in the red color spectrum in color images. In the first stage, the system automatically processed all images in the specified

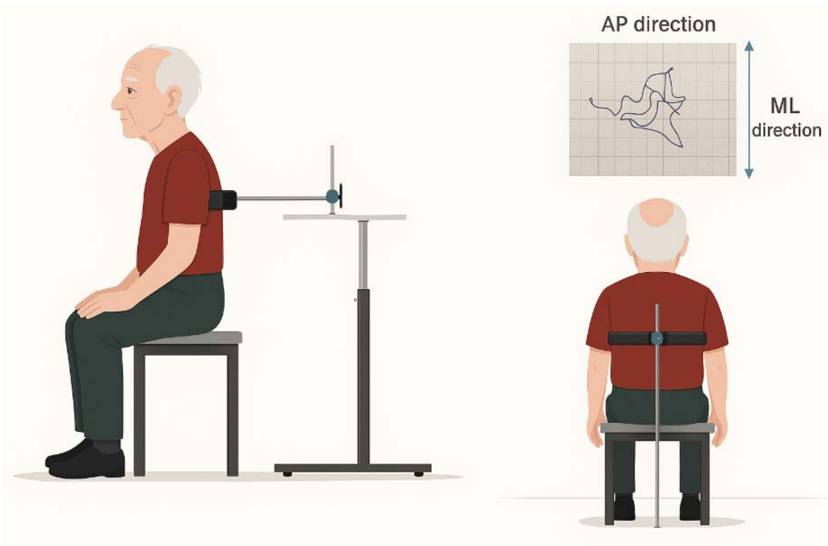

Fig. 1 – Illustration of the Swaymeter measurement procedure. AP – anterior-posterior; ML – mediolateral.

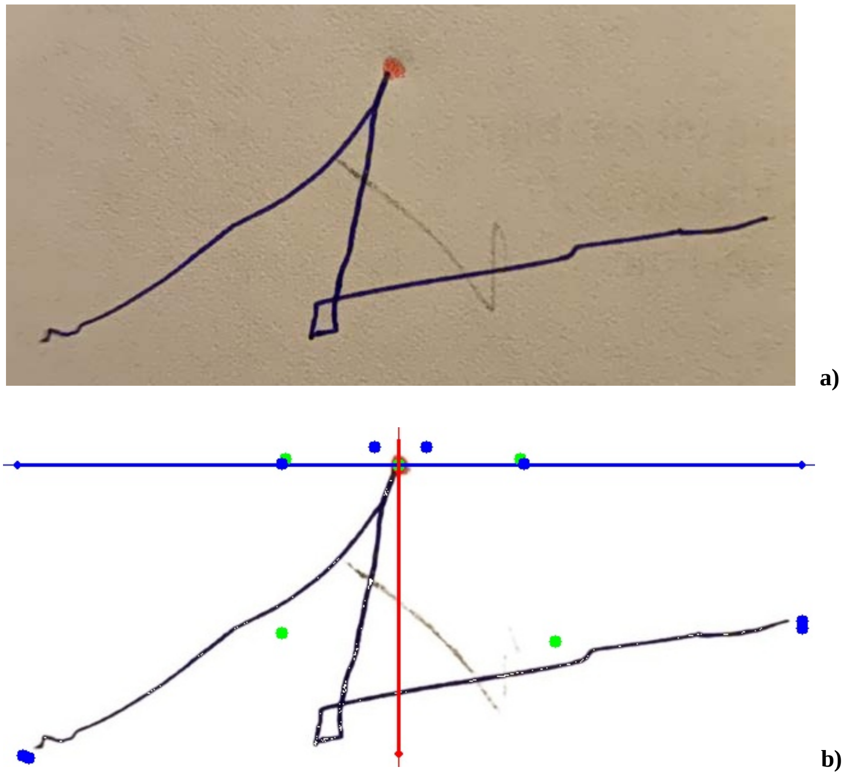

Fig. 2 – a) Original digital image of data prepared by Swaymeter; b) Final image processed by the original image processing algorithm.

directory. Each image was first read and checked for potential reading errors. To facilitate artifact analysis in the image, all black pixels were first converted to white. Subsequently, red regions were detected by masking them with two separate thresholding ranges in the hue, saturation, and value (HSV) color space, and the largest red contour was selected. The geometric center of this red region was calculated using the method of moments, and reference axes, the center point, and arrowheads were drawn on the image for visual verification.

In the first stage, the segmentation performance was optimized by converting the black pixel clusters (red, green, and blue – RGB values ≤ 30) in the image to a white background. Then, the color space was converted from blue, green, red – BGR to HSV, and two adjacent ranges were defined for red tones: (H:0–10, S:100–255, V:100–255 and H:160–180, S:100–255, V:100–255). The pixel clusters in these intervals were merged, morphological operations (erode/dilate) were applied, and noise filtering was performed. When calculating the areas of red objects detected by contour analysis, their centers of gravity were determined using the method of moments (M[“m10”]/M[“m00”], M[“m01”]/M[“m00”]). In the subsequent analysis, the image was divided into four regions (upper right, lower right, upper left, lower left), and the coordinates of the colored pixels in each region were collected separately. For each region, we calculated center coordinates and the Euclidean distance from the center to the target red area (converted from pixels to centimeters). In addition, the coordinates and distance of the boundary point furthest from the center were recorded. These metrics were recorded for objective comparisons. The relevant analysis points and reference lines were visually added to each processed image for verification purposes (Figure 2b).

Assessment of head posture

During the 10 mL thickened water swallow test, participants’ head movements were recorded simultaneously with the Swaymeter measurement. HF-extension and lateral flexion were assessed using the Accell InstantView – AccelView application installed on an Android smartphone attached to the participant’s head. Android-based clinometer applications have demonstrated acceptable reproducibility and accuracy for evaluating head movements in the sagittal and frontal planes [20]. A systematic review and meta-analysis by Sedrez et al. [21] further confirmed that smartphones are valid and reliable tools for assessing cervical range of motion. Specifically, the meta-analysis showed very high correlation coefficients for the evaluation of cervical flexion, extension, and lateral flexion, as well as high correlation coefficients for intrarater and interrater reproducibility of all cervical movements. To avoid restricting spontaneous head movements, the head was not aligned to any fixed reference point. In the analysis, the moment when the participant began swallowing was defined as the zero point. This reference was set within the inclinometer application, and all measurements were evaluated relative to this point. Head movements were analyzed based on the maximum range of motion from the zero point to the final head position reached at the end of the swallowing task (Figure 3).

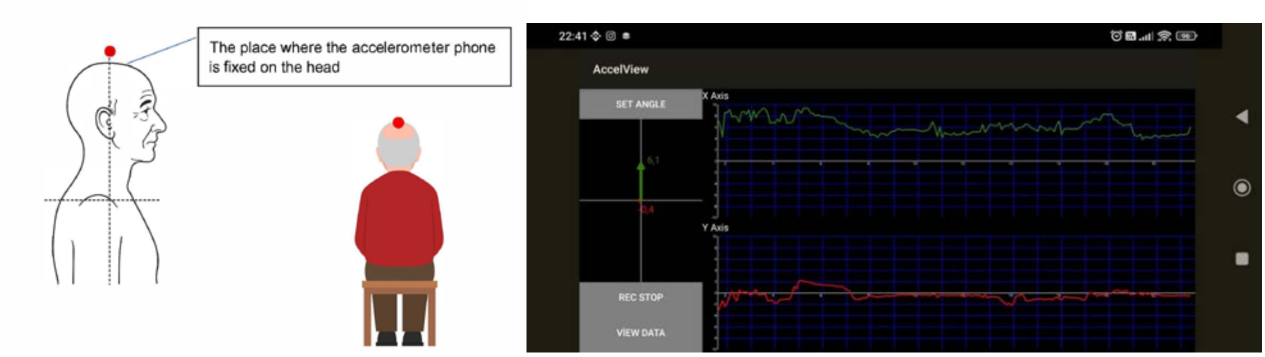

Fig. 3 – Placement of the phone above the head and screenshot of the Accell InstantView – AccelView application.

Collection of qualitative data

Face-to-face interviews were used as the qualitative data collection method in this study. The semi-structured interview guide was developed through a systematic five-phase process to ensure methodological rigor [22], which was described in the text that follows. The first phase involved identifying prerequisites. Semi-structured interviews were deemed appropriate as this method allows exploration of personally sensitive experiences and perceptions regarding swallowing difficulties while enabling participants to freely express their adaptive strategies. The second phase focused on retrieving and using previous knowledge. An initial draft pool of questions was directly informed by key themes identified in previous qualitative studies on the swallowing experiences of nursing home residents [4, 11], establishing a foundational theoretical framework for the interview guide. The third phase involved formulating the preliminary guide. Based on the literature review, a preliminary interview guide was developed with open-ended questions focusing on participants' swallowing experiences, self-developed strategies, and environmental adaptations. The guide included main themes with follow-up questions to encourage detailed responses. The fourth phase involved pilot testing. The preliminary interview guide underwent a rigorous, multi-stage validation process. Expert assessment was conducted by two academic physiotherapy specialists with over 10 years of geriatric rehabilitation experience. They evaluated each item on a 3-point Likert scale (1 = keep as is, 2 = needs revision, 3 = remove completely) while also providing open-ended suggestions for new questions. This expert feedback was then complemented by field-testing through cognitive interviews with eight community-dwelling older adults to assess question clarity, relevance, and feasibility, with revisions implemented based on this comprehensive evaluation. Finally, the fifth phase focused on finalizing the guide. Based on integrated feedback from both experts and participants, revisions were made to question wording and sequence. This iterative development process ensured that the final semi-structured interview form possessed robust content and face validity, making it a rigorous tool for capturing the lived experiences of older adults with swallowing difficulties.

Using this validated instrument, all interviews were audio-recorded. The resulting transcripts were analyzed using qualitative content analysis [23], with data saturation confirmed after conducting interviews with 12 participants identified with spOD.

Statistical analysis

The normality of continuous variables was assessed based on skewness and kurtosis values. Variables with skewness > |2| and kurtosis > |2| were considered non-normal. Normally distributed variables were reported as mean ± standard deviation and compared between groups (spOD vs. non-spOD) using the independent samples *t*-test. The Pearson chi-square test was used to compare categorical variables. These preliminary analyses were conducted to verify that the two groups were comparable with respect to demographic and clinical characteristics before testing the main hypotheses. Correlations between continuous variables were examined using Pearson correlation analysis.

To compare the head movement parameters and TS between groups while controlling for age, body mass index (BMI), and length of stay (LOS), a one-way multivariate analysis of covariance (MANCOVA) was performed. Prior to MANCOVA, the following assumptions were tested: homogeneity of covariance matrices (Box's M test, with $\alpha = 0.005$ due to small sample size), homogeneity of error variances (Levene's test), and homogeneity of regression slopes (group × covariate interactions). Box's M test was non-significant ($p > 0.005$), and the group × covariate interactions were all non-significant ($p > 0.05$), indicating that the assumptions were met. However, the Levene test was significant for some dependent variables ($p < 0.05$). Therefore, the robust Pillai's trace criterion was used for the multivariate test. The multivariate effect of group was considered significant at $p < 0.05$. Following a significant multivariate effect, univariate *F*-tests were performed for each dependent variable. To control for Type I error resulting from multiple comparisons, a Bonferroni correction was applied for the four head movement parameters, adjusting the univariate significance level to $\alpha = 0.0125$ (0.05/4). Partial eta squared (η^2) was reported as a measure of effect size. For TS parameters (eight dependent variables), a separate MANCOVA was conducted using the same covariates. Because Box's M test was significant ($p < 0.001$), Pillai's trace was used, and Bonferroni correction was applied with $\alpha = 0.00625$ (0.05/8).

As a sensitivity analysis, a separate multivariable linear regression (enter method) was performed with maximum HF as the dependent variable and group, age, BMI, Barthel index, feeding time, and sex as independent variables to confirm the robustness of the MANCOVA finding for the primary outcome. All statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

The interview recordings were analyzed using qualitative content analysis [23]. Transcripts were first read holistically, then examined line by line to identify meaning units related to the eating experiences of individuals with spOD. No predefined coding scheme was used; instead, codes were developed inductively during the analysis process.

Results

Quantitative findings

A total of 45 older adults (28 men and 17 women) with a mean age of 73.71 ± 4.52 years participated in this study conducted in nursing homes. The average LOS in the nursing home was 40.44 ± 17.44 months (spOD: 40.19 ± 17.59; non-spOD: 40.66 ± 17.69). The mean Barthel index score was 96.33 ± 4.04 (spOD: 95.23 ± 4.02; non-spOD: 97.29 ± 3.89), and BMI was 27.57 ± 4.32 kg/m² (spOD: 26.59 ± 4.05; non-spOD: 28.43 ± 4.44). No significant differences were found between the groups in terms of these descriptive variables ($p > 0.05$). As expected, the mean swallowing speed was significantly higher in the non-spOD group (18.31 ± 2.73 mL/sec) compared to the spOD group (7.03 ± 1.09 mL/sec) ($p < 0.001$). However, the mean number of swallows was significantly greater in the spOD group (spOD: 5.28 ± 1.00; non-spOD: 3.12 ± 0.74; $p < 0.001$). A significant relationship was observed between feeding time and the presence of spOD ($\chi^2(1) = 7.87$; $p = 0.005$), whereas no significant association was found between sex and the presence of spOD ($\chi^2(1) = 0.002$; $p = 0.96$) (Table 1).

MANCOVA was conducted to determine whether the dependent variables (maximum HF/extansion, post-swallow HF/extansion, maximum lateral flexion, and post-swallow lateral flexion) differed between groups (spOD vs. non-spOD) after controlling for age, BMI, and LOS (Table 2). Preliminary assumption testing showed that the Box's M test for homogeneity of covariance matrices was non-significant, $F(10, 8464.30) = 1.63$, $p = 0.091$. Although Levene's test indicated violations of homogeneity of variance for some variables ($p < 0.05$), Pillai's trace and Wilks' lambda (Wilks' Λ) yielded parallel results; therefore, Wilks' Λ was reported. After controlling for covariates, the main effect of group was significant: Wilks' $\Lambda = 0.59$, $F(4.37) = 6.53$, $p < 0.001$, partial $\eta^2 = 0.41$. Among the covariates, BMI had a significant multivariate effect ($p = 0.023$), whereas age and LOS did not ($p > 0.05$). Following the significant multivariate result, univariate F-tests were performed to identify which dependent variables contributed to the difference. To control for Type I error due to multiple comparisons, a Bonferroni correction was applied, setting the significance level at $p < 0.0125$. Only maximum angle of HF/extension showed a statistically significant group difference, $F(1.40) = 15.69$, $p < 0.001$, partial $\eta^2 = 0.28$. Inspection of the adjusted means (M) revealed that the spOD group had significantly higher maximum angle of HF/extension scores [M = 15.87, standard error (SE) = 2.54] than the non-spOD group (M = 2.25, SE = 2.36). None of the other dependent variables reached statistical significance at the Bonferroni-corrected threshold (all $p > 0.0125$).

MANCOVA was conducted on eight TS parameters (pixel counts and maximum distances in four directions) with age, BMI, and LOS as covariates (Table 3). Preliminary assumption testing using Box's M test indicated a violation of the homogeneity of covariance matrices ($p < 0.001$); therefore, the more robust Pillai's trace criterion was used for the multivariate test. After controlling for age, BMI, and LOS,

Table 1

Descriptive statistics results between groups (spOD vs. non-spOD)

Variable	spOD (n = 21)		non-spOD (n = 24)		*t*-test	*p*-value†
	min–max	mean ± SD	min–max	mean ± SD		
Age, years	65–80	75.09 ± 4.43	65–80	72.5 ± 4.32	-1.98	0.054
BMI, kg/m²	19.9–31.7	26.59 ± 4.05	18.23–34	28.43 ± 4.44	1.45	0.15
LOS, month	13–70	40.19 ± 17.59	14–69	40.66 ± 17.69	0.09	0.92
Barthel index score	90–100	95.23 ± 4.02	90–100	97.29 ± 3.89	1.73	0.09
SwalSpe, mL/sec	5.4–9.52	7.03 ± 1.09	14.64–24.3	18.31 ± 2.73	17.69	< 0.001
nSwal	4–7	5.28 ± 1.00	2–4	3.12 ± 0.74	-8.26	< 0.001
	n (%)		n (%)		$\chi^2(df)$	*p*-valueα
FeTi, min						
< 20	8 (38.1)		19 (79.2)		7.87 (1)	0.005
> 20	13 (61.9)		5 (20.8)			
Sex						
male	13 (61.9)		15 (62.5)		0.002 (1)	0.96
female	8 (38.1)		9 (37.5)			

spOD – screening positive for oropharyngeal dysphagia; non-spOD – screening negative for oropharyngeal dysphagia; n – number; min – minimum; max – maximum; SD – standard deviation; BMI – body mass index; LOS – length of stay; SwalSpe – swallowing speed; nSwal – number of swallows; *df* – degrees of freedom; FeTi – feeding time.

***Note*: † independent samples *t*-test; α Pearson chi-square test.**

Table 2

Univariate group comparisons for head movement parameters

Dependent variable/Group	Adjusted M (SE)	95% CI	$F(1.40)$	p-value	Partial η²
HeadAPM					
spOD	15.87 (2.54)	10.73 – 21.01	15.69	0.0002	0.28
non-spOD	2.25 (2.36)	-2.53 – 7.03			
HeadAPE					
spOD	3.52 (1.28)	0.93 – 6.11	1.83	0.184	0.04
non-spOD	-0.38 (1.19)	-2.79 – 2.03			
HeadLFM					
spOD	0.91 (1.75)	-2.63 – 4.45	1.37	0.249	0.03
non-spOD	-1.67 (1.63)	-4.97 – 1.63			
HeadLFE					
spOD	-0.48 (0.99)	-2.48 – 1.52	0.04	0.835	0.00
non-spOD	-0.91 (0.92)	-2.77 – 0.95			

M – mean; SE – standard error; CI – confidence interval; HeadAPM – head anterior/posterior maximum angle from the start; spOD – screening positive for oropharyngeal dysphagia; non-spOD –screening negative for oropharyngeal dysphagia; HeadAPE – head anterior/posterior end angle from the start; HeadLFM – head lateral flexion maximum angle from the start; HeadLFE – head lateral flexion end angle from the beginning.
***Note*: Controlling for covariates included age, body mass index, and length of stay [adjusted M (SE), 95% CI]. Bonferroni correction was applied (α = 0.0125).**

Table 3

Univariate group comparisons for trunk sway parameters

Dependent variable/Group	Adjusted M (SE)	95% CI	$F(1.40)$	p-value	Partial η²
AntRP					
spOD	2,768.0 (1,641.0)	-544.2 – 6,080.2	0.45	0.505	0.011
non-spOD	3,831.4 (1,530.1)	737.5 – 6,925.3			
AntRM, cm					
spOD	3.25 (0.83)	1.57 – 4.93	1.55	0.22	0.037
non-spOD	4.68 (0.78)	3.10 – 6.26			
PostRP					
spOD	4,962.4 (817.1)	3,310.9 – 6,613.9	3.07	0.087	0.071
non-spOD	3,370.8 (762.1)	1,830.3 – 4,911.3			
PostRM, cm					
spOD	5.66 (1.07)	3.49 – 7.83	4.82	0.034	0.107
non-spOD	2.99 (1.00)	0.97 – 5.01			
AntLP					
spOD	2,781.2 (890.2)	981.7 – 4,580.7	2.02	0.163	0.048
non-spOD	4,424.8 (830.0)	2,746.9 – 6,102.7			
AntLM, cm					
spOD	2.89 (0.77)	1.33 – 4.45	1.27	0.267	0.031
non-spOD	4.08 (0.72)	2.62 – 5.54			
PostLP					
spOD	4,140.4 (1,259.5)	1,593.8 – 6,687.0	0.21	0.65	0.005
non-spOD	3,586.8 (1,174.2)	1,212.5 – 5,961.1			
PostLM, cm					
spOD	5.18 (0.99)	3.18 – 7.18	0.07	0.789	0.002
non-spOD	4.82 (0.92)	2.96 – 6.68			

M – mean; SE – standard error; CI – confidence interval; AntRP – anterior right pixel count; spOD – screening positive for oropharyngeal dysphagia; non-spOD – screening negative for oropharyngeal dysphagia; AntRM – anterior right maximum distance; PostRP – posterior right pixel count; PostRM – posterior right maximum distance; AntLP – anterior left pixel count; AntLM – anterior left maximum distance; PostLP – posterior left pixel count; PostLM – posterior left maximum distance.
***Note*: Controlling for covariates included age, body mass index, and length of stay [adjusted M (SE), 95% CI]. Bonferroni correction applied, significance threshold *p* < 0.00625.**

the multivariate main effect of group was not statistically significant: Pillai's trace = 0.15, $F(8.33) = 0.72$, $p = 0.67$, partial η² = 0.15. No significant difference was observed in the overall TS pattern between the spOD and non-spOD groups. Although the multivariate test was non-significant, univariate F-tests for each dependent variable were examined to provide descriptive information. To control for Type I error due to multiple comparisons, a Bonferroni correction was applied (α = 0.05/8 = 0.00625). After correction, none of the eight variables showed a statistically significant group difference (all $p > 0.006$). The smallest p-value was 0.034 (for posterior right max distance), which remained well above the adjusted threshold. Inspection of the adjusted means revealed similar TS values across groups. Taken together, these findings suggest that TS parameters were comparable between groups, and no evidence was found for an association between spOD and TS during swallowing.

To examine the robustness of the MANCOVA findings, a multivariable linear regression (enter method) was performed with maximum HF as the dependent variable and group, age, BMI, LOS, and sex as independent variables. The regression model was significant and explained 45% of the variance in maximum HF ($R^2 = 0.45$, adjusted $R^2 = 0.38$). As shown in Table 4, after controlling for age, BMI, LOS, and sex, spOD group status (spOD vs. non-spOD) remained significantly and positively associated with maximum HF (B = 13.46, SE = 3.44, 95% CI: 6.50–20.41, β = 0.505, $p < 0.001$). This confirmatory analysis is consistent with the primary MANCOVA finding and suggests that the association between spOD and greater HF during swallowing is independent of potential confounders.

According to the Pearson correlation analysis, age was significantly negatively correlated with swallowing speed ($r = -0.32$, $p = 0.03$) and positively correlated with the number of swallows ($r = 0.39$, $p = 0.007$) (Table 5). A significant negative correlation was also found between swallowing speed and both the number of swallows ($r = -0.81$, $p < 0.001$) and maximum HF in the sagittal plane ($r = -0.55$, $p < 0.001$). Additionally, a significant positive correlation was observed between the number of swallows and maximum HF ($r = 0.43$, $p = 0.003$). No other significant correlations were observed between the remaining variables ($p > 0.05$) (Table 5).

Qualitative findings

Analysis of the semi-structured interviews revealed that participants with spOD had independently developed a wide range of strategies, which were grouped into two main themes (Figure 4). The first main theme was pre-swallow preparation and food adaptation. This theme encompassed strategies employed before the swallowing act itself. Participants consistently reported nutrient bite control ("I always cut my food into very small pieces, like baby food."), mental and physical preparation ("I need to be in a quiet place and focus only on eating."), fluid support ("I take a sip of water after every bite to help it go down."), and nutrient diversion ("I avoid bread because it always gets stuck."). The second theme addressed spontaneous swallowing manoeuvres during swallowing. This theme included behavioral compensations used during the swallow. Participants described reflexive responses such as breath-holding and intentional coughing ("I have to hold my breath and then cough lightly to clear my throat."). Physical support strategies were commonly used, including stabilizing the body by holding onto the chair ("I grip the armrests tightly to keep my body steady.") and keeping shoulders fixed. Additionally, swallowing control manoeuvres such as multiple swallows *per* bite were frequently mentioned.

Table 4

Multivariable linear regression analysis for maximum head flexion

Independent variable	B (95% CI)	SE	β	p-value	Adj R^2	$F(df)$
Constant	-62.63 (-121.2 – -4.05)	28.96	–	0.037		
Group (spOD vs. non-spOD)	13.46 (6.50 – 20.41)	3.44	0.505	< 0.001		
Age	0.75 (-0.02 – 1.53)	0.38	0.253	0.057		
BMI	-0.32 (-1.1 – 0.47)	0.39	-0.102	0.418	0.38	6.41 (5.39)
Length of stay	0.13 (-0.06 – 0.32)	0.09	0.166	0.177		
Sex	-0.53 (-7.34 – 6.28)	3.37	-0.019	0.876		

CI – confidence interval; SE – standard error; Adj – adjusted; ; *df* – degrees of freedom; spOD – screening positive for oropharyngeal dysphagia; non-spOD – screening negative for oropharyngeal dysphagia; BMI – body mass index. *Note*: Dependent variable – maximum head flexion. Predictors were entered simultaneously (enter method). Adjusted R^2 and F value are for the full model.

Table 5

Correlation coefficients among study variables (n = 45)

Variable	Age	SwalSpe	nSwal	HeadAPM	Mean ± SD
Age					
p-value	–	0.03	0.17	0.007	73.71 ± 4.52
r	1	-0.32	0.2	0.39	
SwalSpe					
p-value		–	0.000†	0.000	13.05 ± 6.06
r		1	-0.81	-0.55	
nSwal					
p-value			–	0.003	4.13 ± 1.39
r			1	0.43	

n – number; SwalSpe – swallowing speed; nSwal – number of swallows; HeadAPM – head anterior/posterior maximum angle from the start; SD – standard deviation.

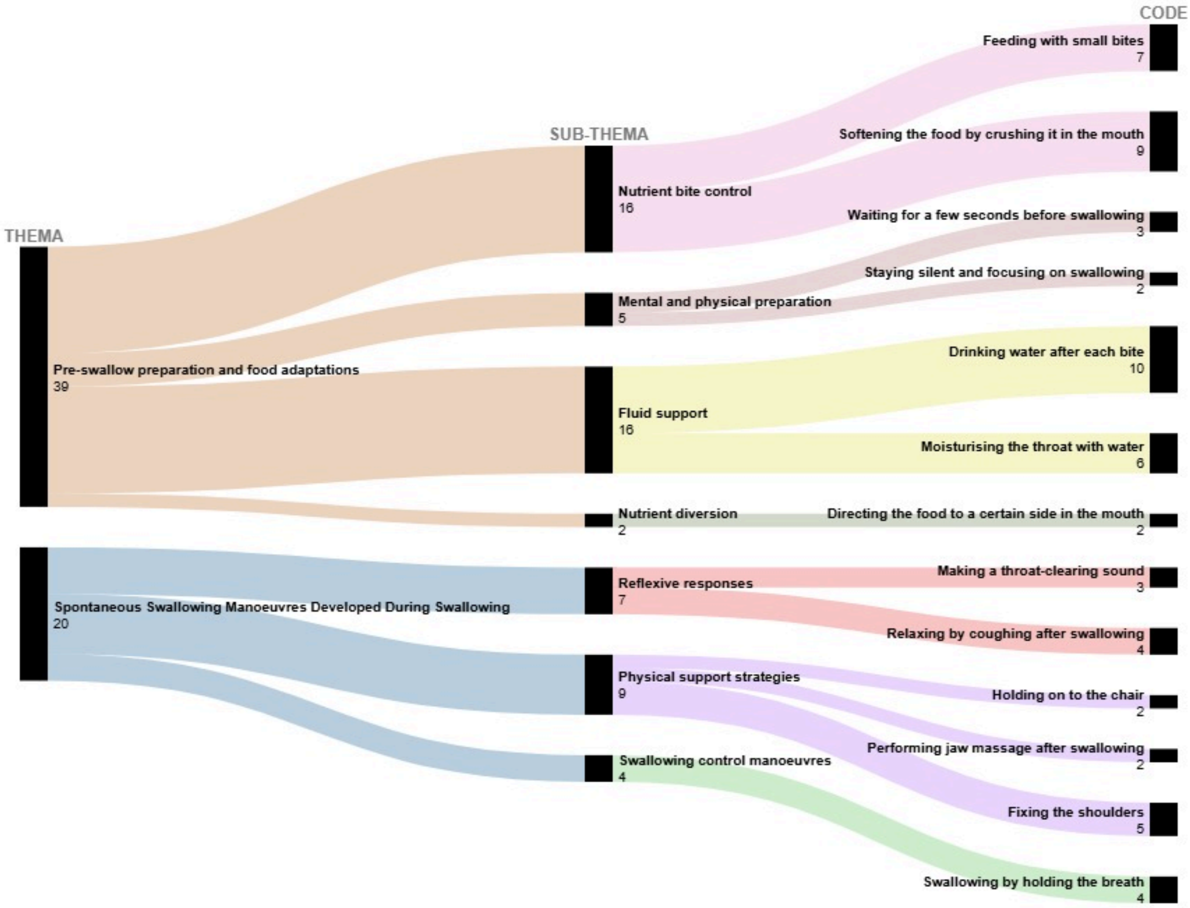

Fig. 4 – Theme-sub-theme-code-frequency distribution (numbers under codes indicate frequency).

Discussion

According to the Pearson correlation analysis, it was noted in the presented study that as age increases, swallowing speed tends to decrease, while the number of swallows increases. Based on the study results, it could also be suggested that lower swallowing speed is associated with a greater number of swallows and increased anterior HF.

This study used a mixed-methods approach to describe spontaneous HPs and TS as observed in older adults in nursing homes with spOD. During swallowing, a significant increase in HF was observed in the spOD group compared to the non-spOD group. After Bonferroni correction, no significant difference was found between the two groups in TS parameters and the angles of other head movements. A positive correlation was found between the maximum HF angle, age, and number of swallows. Additionally, the spOD group showed higher swallowing frequency and longer feeding time. Participants reported various strategies they used to manage swallowing difficulties, including reducing food intake, receiving fluid support, choosing a quiet environment, holding onto a fixed surface, keeping the shoulders level, breath-holding, and reflexive coughing.

Head and neck posture is known to affect swallowing function. Debucean et al. [24] reported that head hyperextension and forward HP are associated with swallowing disorders due to decreased oesophageal patency and changes in the position of the hyoid-related muscles. In contrast, HF and chin tuck (ChT) positions have been reported to enhance swallowing function by accelerating laryngeal closure, reducing pharyngeal residue, and increasing muscle activation [12, 25]. Based on these findings, clinical guidelines recommend that individuals with spOD be trained in HF and ChT positions under the supervision of a healthcare professional [8]. In our study, we observed that individuals with spOD exhibited greater HF angle during swallowing without clinical guidance. One possible interpretation is that this posture may have been acquired through experience; however, our data cannot determine whether it was learned consciously or whether it actually facilitates swallowing. Furthermore, the positive correlation between HF and the number of swallows suggests a relationship, but whether HF directly reduces swallowing effort or improves comfort remains unknown based on these findings.

Qualitative data showed that participants consciously used several physical strategies during swallowing. For instance, some participants fixed their shoulders ("I keep my body still while swallowing"; "I do not move my shoulders."), held onto the chair ("I squeeze my hands on the armrests"; "I feel safer."), or performed jaw massage ("I lightly massage my jaw after swallowing"; "It feels like the food goes down more easily."). These reports reflect explicit, awareness-based coping behaviors. Interestingly, none of the participants mentioned HF during swallowing in the interviews. This is noteworthy because the quantitative part of the study found that the spOD group exhibited significantly greater HF compared to the non-spOD group. One possible reason for this discrepancy is that HF may occur at a less conscious level of motor control, whereas the strategies reported in the interviews are deliberate and easily verbalized. Another possibility is that the semi-structured interview did not include specific questions about HP, which could have led to underreporting of this particular movement. The present study cannot determine whether HF serves a compensatory function or whether it occurs without conscious awareness. However, the fact that HF was observed only in the spOD group and was not verbally reported by participants suggests that this movement may operate outside of deliberate awareness.

Ko et al. [26] reported that performing the ChT manoeuvre with each bite during swallowing may facilitate the swallowing process. The ChT position is considered either a combination of head and neck flexion or a form of isolated HF. In clinical practice, ChT is consciously taught to individuals with spOD [12]. In our study, however, participants with spOD exhibited greater HF during swallowing without any prior training or instruction. This spontaneously observed HF resembles the ChT posture in direction, although it may be a simpler, less refined movement. Our findings cannot determine whether this HF provides the same physiological benefits as the ChT manoeuvre; however, they may generate the hypothesis that spontaneous HF could serve a similar purpose, which should be tested in future studies using direct physiological measures. Although studies examining TS during swallowing are limited, it is well established that temporomandibular joint disorders, occlusal imbalances, tooth loss, and changes in tongue position–as well as simple oral activities such as breathing or chewing gum–can influence postural control and TS in individuals [27–31]. In our study, no significant difference was found in TS parameters of individuals with spOD during swallowing performed in the relaxed sitting position. One possibility is that participants limited their trunk movements, whether consciously or automatically. Qualitative data show that participants reported using physical strategies such as keeping their shoulders still and using the chair for support. These observations are consistent with the recommendations of Gampp et.al. [32], who propose holding onto the chair arms and leaning back to stabilize the trunk during swallowing. Although our data cannot determine whether this is conscious or automatic, qualitative reports of deliberate actions (e.g., holding the chair, fixing the shoulders) suggest that at least some stability is consciously achieved.

A review of the qualitative literature reveals that the spontaneous strategies developed by older adults are largely grounded in individual experiences and, in some cases, align with clinical recommendations. Previous studies have reported that personality and cognition-based approaches–such as imagining a favorite food during swallowing [13], intentionally slowing the swallowing pace [4], or traits like stubbornness [10]–can influence swallowing performance. Participants in our study implemented cognition preparation strategies by choosing a quiet environment and incorporating a brief pause before swallowing. Based on these findings, it can be inferred that cognitive approaches vary among individuals, and that clinicians should consider such experiences in the context of rehabilitation.

While previous qualitative studies have reported fluid-assisted approaches such as softening food with hot water [11] and swallowing with water [4], our study revealed different water-based strategies, including drinking water to moisten the throat and taking fluids regularly after each bite. In addition to reflexive responses reported in previous studies, such as breath-holding during swallowing, participants [4] in our study reported engaging in behaviors such as coughing and throat clearing after each bite. Our study's qualitative findings suggest that spontaneously used swallowing strategies are influenced by personal, cognitive, and environmental factors, and that some elderly people may develop such strategies without having received prior clinical instruction. However, it is considered necessary to support the impact of these participant-reported strategies on swallowing performance through quantitative research.

Limitations of the study

This study has several limitations. First of all, it included only older adults residing in a nursing home; therefore, the findings may not be generalizable to the elderly population living in the community. Since the qualitative data collection process relied on participants' ability to articulate their experiences, some strategies may have been unintentionally underreported. Since the study was designed as cross-sectional, it was not possible to observe changes over time. Frailty, medication burden, and detailed postural assessments were not evaluated; residual confounding cannot be completely ruled out. Classification of participants into spOD and non-spOD groups was based solely on the 100 mL water swallow test, which has a reported specificity of 50%. Consequently, some degree of participant misclassification cannot be excluded. Only a liquid bolus (water) was used. Water swallow tests do not assess the oral preparatory and oral phases, and findings may not generalize to other consistencies (e.g., puree, solid food). Despite these limitations, the study offers valuable insights into the spontaneously developed compensatory strategies of older adults. It quantitatively reveals how such strategies–particularly those related to HP and TS–are employed during swallowing. Findings should be interpreted as exploratory and hypothesis-generating.

Conclusion

This mixed-methods study examined head and trunk movements during swallowing in older adults living in a nursing home who screened positive for oropharyngeal dysphagia. Quantitative findings revealed an association between screening-positive oropharyngeal dysphagia and greater head flexion during swallowing. No significant group differences were observed for trunk sway parameters or other head movements.

In qualitative interviews, participants described various strategies aligned with clinical recommendations (e.g., small bites, drinking water with swallows, choosing a quiet environment). However, none of the participants mentioned head flexion. This discrepancy between the qualitative and quantitative findings raises the possibility that head flexion may occur without explicit awareness. Nevertheless, our study cannot determine whether this movement is conscious or contributes to swallowing safety.

These findings are hypothesis-generating regarding the association between screening-positive oropharyngeal dysphagia and head flexion during swallowing. Clinicians may find it useful to be aware of spontaneously exhibited head postures and self-reported strategies, but further research is needed to determine their potential relevance for rehabilitation. However, findings apply to individuals screening positive for oropharyngeal dysphagia and await confirmation in samples with instrumentally confirmed dysphagia.

R E F E R E N C E S

1. *Ribeiro M, Miquilussi PA, Gonçalves FM, Taveira KVM, Stechman-Neto J, Nascimento WV,* et al. The Prevalence of Oropharyngeal Dysphagia in Adults: A Systematic Review and Meta-analysis. Dysphagia 2024; 39(2): 163–76. DOI: 10.1007/s00455-023-10608-8.
2. *Takizawa C, Gemmell E, Kenworthy J, Speyer R.* A Systematic Review of the Prevalence of Oropharyngeal Dysphagia in Stroke, Parkinson's Disease, Alzheimer's Disease, Head Injury, and Pneumonia. Dysphagia 2016; 31(3): 434–41. DOI: 10.1007/s00455-016-9695-9.
3. *Ortega O, Martín A, Clavé P.* Diagnosis and Management of Oropharyngeal Dysphagia Among Older Persons, State of the Art. J Am Med Dir Assoc 2017; 18(7): 576–82. DOI: 10.1016/j.jamda.2017.02.015.
4. *Hsu WC, Tsai HH, Weng LC, Wang YW.* The experience of eating for older nursing home residents with dysphagia: A qualitative descriptive study. Int J Older People Nurs 2023; 18(6): e12566. DOI: 10.1111/opn.12566.
5. *Engh MCN, Speyer R.* Management of Dysphagia in Nursing Homes: A National Survey. Dysphagia 2022; 37(2): 266–76. DOI: 10.1007/s00455-021-10275-7.
6. *Forster A, Samaras N, Gold G, Samaras D.* Oropharyngeal dysphagia in older adults: A review. Eur Geriatr Med 2011; 2(6): 356–62. DOI: 10.1016/j.eurger.2011.08.007.
7. *Rivelsrud MC, Hartelius L, Bergström L, Løvstad M, Speyer R.* Prevalence of oropharyngeal dysphagia in adults in different healthcare settings: a systematic review and meta-analyses. Dysphagia 2023; 38(1): 76–121. DOI: 10.1007/s00455-022-10465-x.
8. *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): 429. DOI: 10.1186/s12877-021-02366-9.
9. *Melgaard D, Westergren A, Skrubbeltrang C, Smithard D.* Interventions for Nursing Home Residents with Dysphagia—A Scoping Review. Geriatrics (Basel) 2021; 6(2): 55. DOI: 10.3390/geriatrics6020055.
10. *Helldén J, Bergström L, Karlsson S.* Experiences of living with persisting post-stroke dysphagia and of dysphagia management – a qualitative study. Int J Qual Stud Health Well-being 2018; 13(sup 1): 1522194. DOI: 10.1080/17482631.2018.1522194.
11. *Howells SR, Cornwell PL, Ward EC, Kuipers P.* Client perspectives on living with dysphagia in the community. Int J Speech Lang Pathol 2021; 23(2): 201–12. DOI: 10.1080/17549507.2020.1765020.
12. *Nagura H, Kagaya H, Inamoto Y, Shibata S, Ozeki M, Otaka Y.* Effects of head flexion posture in patients with dysphagia. J Oral Rehabil 2022; 49(6): 627–32. DOI: 10.1111/joor.13322.
13. *Moloney J, Walshe M.* "I had no idea what a complicated business eating is…": a qualitative study of the impact of dysphagia during stroke recovery. Disabil Rehabil 2018; 40(13): 1524–31. DOI: 10.1080/09638288.2017.1300948.
14. *Sandelowski M, Voils CI, Barroso J.* Defining and designing mixed research synthesis studies. Res Sch 2006; 13(1): 29.
15. *Küçükdeveci AA, Yavuzer G, Tennant A, Süldür N, Sonel B, Arasil T.* Adaptation of the modified Barthel Index for use in physical medicine and rehabilitation in Turkey. Scand J Rehabil Med 2000; 32(2): 87–92.
16. *Doan TN, Ho WC, Wang LH, Chang FC, Nhu NT, Chou LW.* Prevalence and Methods for Assessment of Oropharyngeal Dysphagia in Older Adults: A Systematic Review and Meta-Analysis. J Clin Med 2022; 11(9): 2605. DOI: 10.3390/jcm11092605.
17. *Wu MC, Chang YC, Wang TG, Lin LC.* Evaluating swallowing dysfunction using a 100-ml water swallowing test. Dysphagia 2004; 19(1): 43–7.
18. *Brodsky MB, Suiter DM, González-Fernández M, Michtalik HJ, Frymark TB, Venediktov R,* et al. Screening accuracy for aspiration using bedside water swallow tests: a systematic review and meta-analysis. Chest 2016; 150(1): 148–63. DOI: 10.1016/j.chest.2016.03.059.
19. *Sturnieks DL, Arnold R, Lord SR.* Validity and reliability of the Swaymeter device for measuring postural sway. BMC Geriatr 2011; 11: 63. DOI: 10.1186/1471-2318-11-63.
20. *Ghorbani F, Kamyab M, Azadinia F.* Smartphone Applications as a Suitable Alternative to CROM Device and Inclinometers in Assessing the Cervical Range of Motion in Patients With Nonspecific Neck Pain. J Chiropr Med 2020; 19(1): 38–48. DOI: 10.1016/j.jcm.2019.10.004.
21. *Sedrez JA, Furlanetto TS, Gelain GM, Candotti CT.* Validity and reliability of smartphones in assessing spinal kinematics: a systematic review and meta-analysis. J Manipulative Physiol Ther 2020; 43(6): 635–45. DOI: 10.1016/j.jmpt.2019.10.012.
22. *Kallio H, Pietilä AM, Johnson M, Kangasniemi M.* Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. J Adv Nurs 2016; 72(12): 2954–65. DOI: 10.1111/jan.13031.
23. *Pope C, Mays N.* Qualitative research in health care. 3rd ed. USA: John Wiley & Sons; 2013. p. 168.
24. *Debucean D, Mihaiu J, Maghiar AM, Marcu F, Marcu OA.* A Multidisciplinary Approach to Swallowing Rehabilitation in Patients with Forward Head Posture. Medicina (Kaunas) 59(9): 1580. DOI: 10.3390/medicina59091580.
25. *Matías Ambiado-Lillo M.* Impact of Head and Neck Posture on Swallowing Kinematics and Muscle Activation: A Systematic Review. Dysphagia 2025; 40(5): 1049–54. DOI: 10.1007/s00455-025-10821-7.
26. *Ko JY, Shin DY, Kim TU, Kim SY, Hyun JK, Lee SJ.* Effectiveness of Chin Tuck on Laryngeal Penetration: Quantitative As-

sessment. Dysphagia 2021; 36(6): 1054–62. DOI: 10.1007/s00455-020-10238-4.

27. *Peng CH, Pauloski BR.* Ultrasonography as Biofeedback to Increase Muscle Activation During the Mendelsohn Maneuver in Healthy Adults. Dysphagia 2023; 38(4): 1156–68. DOI: 10.1007/s00455-022-10542-1.
28. *Alghadir AH, Zafar H, Iqbal ZA.* Effect of tongue position on postural stability during quiet standing in healthy young males. Somatosens Mot Res 2015; 32(3): 183–6. DOI: 10.3109/08990220.2015.1043120.
29. *Fadillioglu C, Kanus L, Möhler F, Ringhof S, Hellmann D, Stein T.* Influence of controlled stomatognathic motor activity on sway, control and stability of the center of mass during dynamic steady-state balance - an uncontrolled manifold analysis. Front Hum Neurosci 2022; 16: 868828. DOI: 10.3389/fnhum.2022.868828.
30. *Goto F, Kushiro K, Tsutsumi T.* Effect of chewing gum on static posturography in patients with balance disorders. Acta Otolaryngol 2011; 131(11): 1187–92. DOI: 10.3109/00016489.2011.607846.
31. *Schmid M, Conforto S, Bibbo D, D'Alessio T.* Respiration and postural sway: detection of phase synchronizations and interactions. Hum Mov Sci 2004; 23(2): 105–19. DOI: 10.1016/j.humov.2004.06.001.
32. *Gampp Lehmann K, Sticher H.* Posture and Function: What Helps Us Swallow. In: *Nusser-Müller-Busch R, Gampp Lehmann K*, editors. Facial-Oral Tract Therapy (FOTT): For Eating, Swallowing, Nonverbal Communication and Speech. Cham: Springer; 2021. pp 45–72. DOI: 10.1007/978-3-030-51637-6_4.

Received on October 19, 2025
Revised on May 10, 2026
Revised on June 28, 2026
Accepted on July 8, 2026
Online First August, 2026