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Impact of sarcopenia on swallowing and vocal functions in elderly adults: a prospective comparative study

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Abstract

Background Sarcopenia, characterized by the progressive loss of muscle mass and strength, commonly affects the elderly and is associated with increased physical disability, decreased quality of life. This study aims to assess the effect of sarcopenia on swallowing and voice functions in geriatric patients using objective and subjective evaluation methods.

The study included 40 participants aged 65 and older, divided into sarcopenic ($n = 20$) and control ($n = 20$) groups based on the SARC-F questionnaire and handgrip strength measurements. Swallowing function was evaluated with fiberoptic endoscopic evaluation of swallowing (FEES) and the Eating Assessment Tool (EAT- 10). Vocal function was analyzed using acoustic voice analysis—fundamental frequency (F0), jitter, shimmer, and harmonic-to-noise ratio (HNR)—, maximum phonation time (MPT) and the Voice-Related Quality of Life (VRQOL) questionnaire.

Results The prevalence of dysphagia was higher in the sarcopenic group, with a mean EAT- 10 score of 2.55 ± 3.64 compared to 1.5 ± 2.3 in controls ($p = 0.032$). Although the sarcopenic group exhibited slightly higher PAS scores, no aspiration was observed in either group. Acoustic analysis showed no significant differences in F0, jitter, shimmer, or HNR between groups; however, MPT was significantly shorter in the sarcopenic group (8.3 ± 2 s vs. 9.8 ± 2.1 s, $p = 0.026$). VRQOL scores were lower in sarcopenic participants, though not statistically significant.

Conclusions Sarcopenia appears to be associated with subtle but measurable impairments in swallowing and voice functions in older adults. Although most acoustic and endoscopic parameters did not differ significantly, higher dysphagia scores and reduced maximum phonation time in sarcopenic individuals suggest early functional decline. These findings highlight the importance of comprehensive laryngopharyngeal assessments in geriatric patients with sarcopenia.

Keywords Dysphagia, Dysphonia, Sarcopenia, Swallow, Voice quality

Background

Sarcopenia is a syndrome characterized by progressive and widespread loss of muscle mass and strength, leading to physical disability, decreased quality of life, and increased mortality. It predominantly affects the geriatric population [1]. The prevalence of sarcopenia in older adults ranges from 5 to 50%, influenced by factors such as age, gender, comorbid conditions, and the diagnostic criteria used [2]. The loss of muscle mass and strength decreases physical performance and may lead to functional problems.

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Sarcopenic dysphagia is a clinical entity defined as difficulty swallowing due to sarcopenia. It was first described by Kuroda et al. and that has gained increasing recognition from that time [3]. Its prevalence remains uncertain due to the novelty of the concept and the heterogeneity of assessment methodologies. Several studies have investigated the association between sarcopenia and dysphagia, and many have reported a higher incidence of dysphagia in sarcopenic patients [4–6]. Early identification of factors indicative of a decline in swallowing function is crucial for timely intervention, potentially preventing the progression of dysphagia.

Another functional issue potentially associated with sarcopenia is vocal changes. Sarcopenia may affect the vocal muscles, leading to compromised voice quality. Reduced voice quality negatively impacts the quality of life in geriatric patients, potentially contributing to social isolation and depression, which may result in them becoming homebound [7]. Therefore, voice changes should not be dismissed as a natural consequence of aging. The underlying predisposing factors must be identified, and strategies for intervention should be developed.

In this study, our objective was to examine the impact of sarcopenia on voice and swallowing function through the application of both objective and subjective assessment methods. We compared the findings with those from a non-sarcopenic geriatric group to directly assess the effects of sarcopenia. To the best of our knowledge, this is the first study in the literature to investigate the effects of sarcopenia on vocal functions.

Methods

The study was approved by the institutional ethics committee (2022–09/25) and conducted in accordance with Good Clinical Practice guidelines and applicable regulatory requirements. Written informed consent was obtained from all participants. The study was carried out between May 2022 and May 2023 in the Department of Otorhinolaryngology at a university hospital. Participants were recruited using a consecutive sampling method. All eligible individuals aged 65 and over who presented to the otorhinolaryngology outpatient clinic and met the inclusion criteria were invited to participate. Enrollment continued consecutively until the target of 20 sarcopenic and 20 control participants was reached.

Patients with a history of neurological disorders (e.g., Parkinson's disease, Alzheimer's disease, stroke, multiple sclerosis, amyotrophic lateral sclerosis), head and neck malignancies, prior head, neck, chest, or upper gastrointestinal surgery, pulmonary diseases (e.g., chronic obstructive pulmonary disease, asthma), gastrointestinal disorders (e.g., gastroesophageal reflux disease, achalasia, Zenker's diverticulum), active airway infection, history of radiotherapy or chemotherapy, or any other condition or surgical intervention that could directly affect swallowing or voice function were excluded from the study.

First, the SARC-F questionnaire was administered to all participants to identify probable sarcopenia [8]. Participants scoring below 4 on the questionnaire were assigned to the control group. Participants with scores of 4 or higher, underwent a handgrip strength dynamometer test to confirm a potential diagnosis of sarcopenia. Patients with handgrip strength below 16 kg for women and 27 kg for men were classified as probable sarcopenia and evaluated in study group [9]. Following group allocation, each participants' swallowing, and voice functions were systematically evaluated. Same procedures were followed for each subject.

Fiberoptic video laryngoscopy (Karl Storz, GmbH & Co KG, Tuttlingen, Germany) was performed and glottal closure patterns were noted. No topical anesthetics were applied prior to the procedure to avoid suppressing the sensory response. Swallowing function was then assessed using liquid (green-dyed water), semi-solid (green-dyed pudding), and solid (cracker) consistencies. Findings of aspiration and penetration were documented. The procedure was video-recorded, and all FEES examinations were rated by a single clinician with over 5 years of experience in performing and interpreting FEES. PAS scores were determined based on the worst (maximum) score observed across trials.

Acoustic and aerodynamic voice analysis were conducted with the PRAAT software (Version 6.1; Amsterdam; Netherlands) in an acoustically treated setting. Participants were instructed to sustain the vowel/a/at a comfortable volume and measurements of fundamental frequency (F0 in Hz), jitter (%), shimmer (%), and harmonic-to-noise ratio (HNR in dB) were recorded. Maximum phonation time (MPT) was assessed by asking participants to take a deep breath and sustain the/a/ sound for as long as possible. Three consecutive trials were performed with a one-minute rest period between each period and the maximum value was recorded for the analysis.

The Voice-Related Quality of Life (VRQOL) questionnaire was used for subjective voice evaluation [10]. Social emotional (VRQOL-SE) subdomain and physical functional subdomain (VRQOL-PF) were evaluated.

A standardized fiberoptic endoscopic evaluation of swallowing (FEES) procedure used to assess swallowing functions. Evaluations were scored according to the penetration-aspiration scale (PAS) [11]. Subjects were

asked to fill the 10-item eating assessment tool (EAT-10) [12]. If EAT- 10 score is 3 or higher, it was considered as presence of dysphagia [13].

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA). Data distribution was assessed through both visual (histogram and probability plots) and analytical methods, using the Kolmogorov–Smirnov test for larger samples and the Shapiro–Wilk test for smaller samples. Descriptive statistics were presented as mean ± standard deviation for normally distributed continuous numerical variables, and as median (minimum–maximum) for non-normally distributed variables. Comparisons between the sarcopenia and non-sarcopenia groups were performed using a two-sample *t*-test for normally distributed data and the Mann–Whitney *U* test for non-normally distributed data. All statistical tests were two-tailed, and a p-value < 0.05 was considered statistically significant.

Results

The study sample consisted of 40 individuals. Twenty of the subjects were in the sarcopenia group and 20 in the control group. The gender distribution of the patients in the sarcopenia group was 10 males and 10 females. The mean age was 82.8 (min 69–max 94) years. The gender distribution in the control group was similarly 10 males and 10 females. The mean age of the patients was 80.75 (min 67–max 91) years. No significant difference was observed between the two groups in terms of age or gender.

The most common presenting complaints to the ENT outpatient clinic included hearing loss, tinnitus, nasal obstruction, and vertigo. None of the participants reported dysphagia or dysphonia as their primary reason for seeking ENT evaluation.

Neither group had patients reporting dysphagia or hoarseness as their main complaint. However, the prevalence of dysphagia was 27.5% across the entire sample, as measured by the EAT- 10. The mean EAT- 10 score was 2.55 ± 3.64 in the sarcopenia group and 1.5 ± 2.3 in the control group, with the difference being statistically significant (p = 0.032). No aspiration was observed in any subjects during their FEES exams. While the PAS scores were higher in the sarcopenia group, this difference was not statistically significant ($p = 0.102$).

Endoscopic larynx evaluations revealed no structural or functional pathology in 29 subjects. A glottal closure gap was observed in 5 patients in the sarcopenia group and 6 patients in the control group. The acoustic voice analysis parameters were compared between groups. The mean F0 values in the sarcopenia group was 163.1 ± 42.9 Hz, while in the control group it was 174.5 ± 43.1 Hz. The difference was not statistically significant ($p = 0.48$). Similarly, the mean HNR was 12.63 ± 4.5 dB in the sarcopenia group and 13.2 ± 4.9 dB in the control group, showing no significant difference ($p = 0.70$). In the sarcopenic patients, the mean jitter was 2.14 ± 2, and shimmer was 4.2 ± 3.85. In the control group, the jitter and shimmer values were 1.8 ± 2.13 and 3.67 ± 3.9, respectively, with no statistically significant differences between the groups ($p = 0.76$). The mean MPT was notably shorter in the sarcopenia group at 8.3 ± 2 s, compared to 9.8 ± 2.1 s in the control group, the difference was statistically significant ($p = 0.026$). When comparing V-RQOL scores, both the physical-functional and social-emotional sub-dimensions were lower in the sarcopenia group than in the control group, though these differences were not statistically significant.

The swallowing and voice outcomes in both groups were summarized in Table 1.

Discussion

As the global population ages, the approach to geriatric patients and conditions like sarcopenia has gained increasing attention in the literature. This study's findings contribute valuable insights into how sarcopenia affects swallowing and voice functions, highlighting the clinical implications of this condition in elderly patients.

The overall prevalence of dysphagia in the present study was 27.5%, which aligns with previous reports in the literature that estimate prevalence in geriatric populations between 26% and 42.3% [14]. For instance, Maeda et al. reported a dysphagia prevalence of 30% among hospitalized elderly patients [15]. Most studies on sarcopenic

Table 1 Swallowing and voice outcomes in sarcopenia and control group

	Sarcopenia group ($n = 20$)	Control group ($n = 20$)	Total ($n = 40$)
EAT- 10 (mean)*	2.55	1.50	2.02
F0 (Hertz)	163.1 ± 42.9	174.5 ± 43.1	164.7 ± 49.8
HNR (dB)	12.6 ± 4.5	13.2 ± 4.9	12.9 ± 4.7
Jitter (%)	2.1 ± 2	1.8 ± 2.1	1.7 ± 2.0
Shimmer (%)	4.2 ± 3.8	3.6 ± 3.9	3.9 ± 3.8
MPT (sec)*	8.3 ± 2.0	9.8 ± 2.1	9.0 ± 2.1
VRQOL-PF (mean)	92.5 ± 9.1	94.7 ± 8.6	93.0 ± 8.6
VRQOL-SE (mean)	92.8 ± 8.1	93.5 ± 8.3	93.7 ± 8.3

EAT- 10 Eating Assessment Tool, *F0* Fundamental frequency, *HNR* Harmonic Noise Ratio, *MPT* maximum phonation time, *VRQOL-PF* Voice-Related Quality of Life-Physical Functional, *VRQOL-SE* Voice-Related Quality of Life-Social Emotional

* Significant p value < 0.05

dysphagia have focused on hospitalized patients; however, this study evaluated swallowing and voice functions in geriatric patients who presented to an ENT outpatient clinic, independent of their specific complaints. This outpatient setting may have led to the exclusion of patients with more severe sarcopenia, potentially lowering the observed dysphagia prevalence relative to some studies in the literature. Differences in dysphagia prevalence across studies likely reflect variations in sample demographics and the diagnostic methods used.

In our study, EAT- 10 scores were higher in the sarcopenic group compared to the non-sarcopenic geriatric population. When interpreting these results, it is important to consider normative data. Garand et al. evaluated EAT- 10 scores in a large sample of healthy, community-dwelling adults and found that the mean score was 0.6 ± 1.6, with over 85% of participants aged 60 and older scoring within the normal range (0–2) [16]. Although the sarcopenic group in our study showed higher mean EAT-10 scores than controls, the majority of participants in both groups still had scores of 0. This suggests that while the difference was statistically significant, its clinical significance may be limited. Future studies incorporating patient-centered outcome measures and objective assessments of swallowing function are needed to clarify the real-world impact of sarcopenia-related dysphagia.

Swallowing was also assessed using the PAS during FEES. No aspiration events were observed in either group. Although PAS scores were slightly elevated in the sarcopenic group, the sample size was insufficient to detect a statistically significant association. Further investigation of sarcopenia prevalence among older adults with elevated PAS scores may help clarify the relationship between sarcopenia and airway invasion.

Additionally, age-related changes in swallowing function—referred to as presbyphagia—were not explicitly addressed in this study but may have influenced the findings. These physiologic changes can occur in the absence of overt dysphagia and may overlap with features of sarcopenic dysphagia. The modest differences observed between groups may, in part, reflect the presence of presbyphagia in both cohorts. Future research should consider stratifying participants by dysphagia risk to better differentiate the effects of sarcopenia from those of normal aging.

Voice production in elderly individuals changes in many ways. The loss of connective tissue in the larynx, thickening of the superficial layer of the lamina propria, edema, degeneration and atrophy of elastic fibers, and atrophy in myofibrils lead to structural and functional changes. These changes are named as presbylarynx [17, 18]. Endoscopic larynx evaluation was used to evaluate presbylarynx findings in the study. The most common presbylarynx finding was the glottal gap, observed in 27.5% of the sample. Although it was hypothesized that vocal cords might be more affected in sarcopenia due to decreased muscle mass and function, the data did not support this hypothesis. The glottal gap rate was not higher in the sarcopenic group. Repeating the study in larger samples and interpreting the endoscopic images with image analysis programs may produce more sensitive and meaningful results.

Presbyphonia findings were evaluated using acoustic analysis parameters in the study. To interpret the impact of sarcopenia on acoustic parameters, it is essential to consider the effects of aging on these parameters. Study by Deliyski et al. on age-related changes in acoustic parameters indicate that individuals over 70 tend to have lower F0, greater variations in frequency and intensity, and lower HNR compared to younger and middle-aged adults [19]. Similarly, Dehqan et al. found that elderly men had a higher F0 than younger men, whereas elderly women had a lower F0 than their younger counterparts. In elderly participants, both shimmer and jitter were significantly elevated, and the HNR was notably reduced [20]. In all these studies, the geriatric voice was compared with the young voice. In this study, the sarcopenia group was compared with the control group aged 65 and over, focusing on the specific effect of sarcopenia on the geriatric voice. The F0 was found to be lower in the sarcopenia group. It is difficult to interpret this difference clinically. It may be significant if repeated results are obtained in large samples. Perturbation parameters were higher, and HNR was lower in the sarcopenia group, suggesting that sarcopenia may negatively impact voice quality.

The study revealed that MPT was significantly shorter in the sarcopenia group. MPT is influenced by various factors, including age, gender, and comorbidities. Given that our study groups were matched in age and gender, the observed reduction in MPT in the sarcopenia group likely reflects the impact of sarcopenia itself, potentially through the weakening of respiratory muscles.

Interestingly, the VRQOL scores were measured high in the study and control groups. Since voice changes do not occur suddenly in the elderly, these changes may be perceived as a normal part of aging, potentially minimizing their impact on quality of life. Additionally, factors like social isolation and reduced involvement in work life among older adults may decrease the frequency of voice use, making voice changes less noticeable. Although VRQOL scores were lower in the sarcopenic group than in the control group, this difference was not statistically significant. Using a subjective voice assessment tool specifically designed for the elderly, such as the Aging Voice Index [21], might more accurately capture age-related voice changes. However, the AVI was not used in this

study, as its validity and reliability have not yet been tested in study population's language.

This study has several limitations. First, while FEES was performed, the analysis was limited to the PAS. Other important pharyngeal parameters such as residue, laryngeal elevation, and velopharyngeal closure were not systematically evaluated. A more detailed FEES scoring system could provide a broader assessment of swallowing physiology. Second, GERD which can influence both voice and swallowing functions, was not assessed. Although patients with diagnosed GERD were excluded, asymptomatic or undiagnosed reflux could have introduced confounding effects. Future studies should consider incorporating reflux symptom questionnaires and/or pH monitoring when evaluating voice and swallowing in this population.

Another limitation is the absence of formal assessment of potential confounding variables such as comorbidities, nutritional status (e.g., BMI), and physical activity level. These factors are known to influence both voice and swallowing functions independently and may have contributed to variability in our findings. Although we excluded participants with specific diagnoses that could directly affect swallowing or phonation, subclinical or unreported conditions may still have been present. Future studies should include standardized tools to evaluate nutritional status and physical activity, and adjust for these variables in the analysis to better isolate the effects of sarcopenia.

Conclusion

This study demonstrates that sarcopenia may negatively influence both swallowing and voice functions in older adults, even in the absence of overt symptoms. While subjective dysphagia scores and maximum phonation time were significantly worse in sarcopenic individuals, most acoustic and endoscopic parameters did not show statistically significant differences. These findings suggest that sarcopenia may contribute to subtle functional impairments that are not always captured by standard clinical assessments. Early identification and targeted interventions focusing on vocal and swallowing rehabilitation may help mitigate the impact of sarcopenia in the geriatric population. Future research with larger sample sizes and more comprehensive assessment tools is warranted to further clarify the relationship between sarcopenia and laryngopharyngeal function.

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Authors' contributions
All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by SY and SB. The first draft of the manuscript was written by SB and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Acibadem University (2022–09/25 Date:20/05/2022). Written informed consent was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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