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Investigating Swallowing Performance and Swallowing-Related Quality of Life Across Alzheimer's Stages

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Abstract

Objective: Alzheimer's disease (AD) is a progressive neurodegenerative disorder frequently accompanied by dysphagia, leading to malnutrition, dehydration, and aspiration pneumonia. While AD's general impact on the quality of life is well-documented, the specific influence of swallowing disorders on the quality of life remains underexplored. This study aimed to investigate the relationship between swallowing function and swallowing-related quality of life across different stages of AD.

Material and Methods: A total of 45 individuals aged 65 years diagnosed with AD were enrolled and classified into three groups-mild, moderate, and severe-based on Clinical Dementia Rating (CDR) scores, with 15 patients in each group. Swallowing function was assessed using the Eating Assessment Tool (EAT-10), the Timed Water Swallowing Test (TWST), and the Repeated Saliva Swallowing Test (RSST). Nutritional status was evaluated using the Mini Nutritional Assessment-Short Form (MNA-SF), and swallowing-related quality of life was measured using the Swallowing Quality of Life Questionnaire (SWAL-QOL).

Results: Higher CDR scores were positively correlated with EAT-10 scores, indicating greater perceived swallowing difficulties, and negatively correlated with SWAL-QOL, TWST, RSST, and MNA-SF scores ($p<0.001$). As AD severity increased, patients demonstrated reduced swallowing performance, poorer nutritional status, and lower quality of life. Statistically significant differences were observed in all measured outcomes across disease stages ($p = 0.000$), with the severe group showing the most deterioration.

Conclusion: This study highlights a strong link between AD progression and impairments in swallowing function, nutrition, and related quality of life, emphasising the need for early dysphagia screening and timely nutritional interventions in clinical care.

Keywords Alzheimer's disease · dysphagia · swallowing · quality of life · dementia

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INTRODUCTION

Dementia is a disease characterised by the impairment of multiple cognitive functions and encompasses various aetiological causes. In this sense, AD is identified as the most common cause of dementia, accounting for a significant proportion of aetiological cases (1, 2). The ageing population of the world and the increasing prevalence of risk factors associated with AD have led to a significant rise in the number of individuals affected by this disease (3, 4). The progressive nature of AD leads to various health issues for patients, one of them being dysphagia (5, 6).

Dysphagia is a condition characterised by swallowing difficulties and can lead to serious complications such as malnutrition, sarcopenia, and infections (7, 8). In addition, dysphagia has been reported to cause a significant decline in patients' quality of life and an increased risk of mortality (9). Although dysphagia can be observed in the early stages of AD, it becomes more prominent as the disease progresses. Research in the literature indicates that dysphagia is present in 90% of hospitalised individuals with dementia and in 84%–93% of individuals in the moderate to severe stages of AD (10).

Dysphagia not only disrupts the swallowing process in Alzheimer's patients but also adversely affects their nutrition and fluid intake, potentially leading to serious complications such as malnutrition, dehydration, and weight loss (11, 12). Especially in the severe stage, aspiration pneumonia stands out as one of the main causes of mortality. This condition is closely linked to penetration and aspiration risks, as well as oral residues, which can be observed across all stages of the disease. The literature indicates that the likelihood of aspiration is significantly higher in individuals with AD than those without the condition (13). In addition, the risk of death due to aspiration pneumonia in individuals with AD and dysphagia is two times higher than that in individuals who do not aspirate (14).

Although dysphagia is more common in the severe stage of AD, there is no clear information regarding the exact onset of dysphagia throughout the process. However, research reveals that dysphagia symptoms can emerge even in the mild stage (6). Therefore, recent studies involving individuals with Alzheimer's emphasise the importance of assessing these individuals for dysphagia from the early stages on (15). In AD, dysphagia manifests in the early stages with symptoms such as decreased senses of taste and smell, decreased saliva production, and delayed swallowing reflexes. In the moderate stages, complications become more common, including prolonged oral preparation time, delays in oral transit, difficulty triggering the swallowing reflex, reduced pharyngeal clearance, and an increased risk of aspiration. In the severe stages, this condition worsens, leading to high aspiration risks and serious and potentially fatal outcomes such as aspiration pneumonia. As the disease progresses, the decline in cognitive and functional abilities contributes to the prevalence of behavioural eating disorders, negatively affecting both nutrition and swallowing abilities (16). Moreover, dysphagia not only leads to a significant decline in the quality of life for individuals with AD but also their caregivers (3). Research has shown that dysphagia dramatically reduces the quality of life of individuals with neurodegenerative diseases, such as AD (17). In the literature, there are studies examining the quality of life for individuals with AD in relation to their cognitive status, level of independence, eating habits, and malnutrition. These studies address these factors individually or analyse them together (18-21). However, these studies have not sufficiently focused on how AD affects the quality of life in relation to swallowing functions. This gap highlights the need for a more comprehensive examination of the multifaceted impact of swallowing disorders on individuals' quality of life.

Swallowing-related quality of life assessments are used as an important tool to measure the impact of diseases and treatments (22). In dysphagia rehabilitation, patient-reported outcome measures are crucial for better understanding the physiological and psychosocial aspects of swallowing disorders (23). Such assessments are essential for observing the effectiveness of treatment approaches aimed at improving patients' quality of life, as well as for gaining a more comprehensive understanding of the various dimensions of swallowing disorders. In this context, a more detailed investigation of the relationship between swallowing disorders and quality of life in patients with Alzheimer's disease will facilitate the development of more effective treatment and care strategies for both patients and caregivers. Accordingly, this study aimed to investigate the relationship between swallowing performance and swallowing-related quality of life across the stages of AD. Within the scope of this study, we investigated whether there are significant changes in swallowing performance across different stages of AD, whether a decline in swallowing-related quality of life occurs as the disease progresses, and whether there is a statistically significant relationship between swallowing performance and swallowing-related quality of life.

MATERIAL AND METHODS

Participants

This study was conducted between August and December 2024 at the Neurology Clinic of Atlas University Hospital

with 45 AD participants aged ≥65 who were diagnosed with the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) and the diagnostic criteria of the AD and Related Disorders Association (ARDA) (24, 25). The participants were recruited based on the following inclusion criteria: (i) being at one of the stages of Alzheimer's according to the CDR, (ii) having only Alzheimer's type dementia, and (iii) not having any additional neurological diseases (e.g., Parkinson's disease, multiple sclerosis, or stroke). Patients with other disorders that could affect swallowing function (e.g., head and neck cancer), those with a history of dysphagia prior to the Alzheimer's diagnosis, and those with hearing loss to a degree that could affect the scale results were excluded from the study. Each patient's disease stage was determined using the Clinical Dementia Rating (CDR) scale-which evaluates six domains (memory, orientation, judgement and problem-solving, community affairs, home and hobbies, and personal care)-by a neurologist with over 15 years of clinical experience (26). According to the CDR scores, the participants were grouped into the mild AD (CDR 1), moderate AD (CDR 2), and severe AD (CDR 3) stages. Informed written consent were obtained from all participants who met the specified inclusion criteria. The study was approved by the Ethics Committees of İstanbul Atlas University (Date: 22.07.2024, No: 46523) and was conducted in accordance with the Declaration of Helsinki.

Data collection tools

In this study, the following data collection tools were administered to the participants: the Eating Assessment Tool (EAT-10), the Repetitive Saliva Swallowing Test (RSST), the Timed Water Swallowing Test (TWST), the Swallowing Quality of Life Questionnaire (SWALL-QOL), and the Mini Nutritional Assessment Short Form (MNA-SF).

The questionnaires were administered individually in a quiet, private room reserved for interviews, in a single session, and took an average of 45 minutes per participant. Information was collected from each participant and their primary caregiver, who was familiar with the participant's eating behaviour. Due to the significant decline in cognitive and communication abilities observed in individuals with advanced-stage AD, data for patients at this stage were obtained exclusively from their primary caregivers, who provided care for at least 20 h per week and were capable of offering reliable information about the patient's functional status. This approach aimed to overcome the limitations associated with obtaining direct self-reports from the individuals themselves. Furthermore, it was emphasised that a "symptom" should represent a significant change from the participant's pre-disease condition rather than a long-standing characteristic.

To ensure accurate responses and reduce the possibility of misinterpretation due to low education levels or visual impairments, the researcher read the questionnaire items and answer options aloud to each participant. The aim was to enhance the comprehensibility of the questionnaire and minimise the possibility of misguiding responses. Consistency was maintained by administering the questionnaires in the same manner to each participant, avoiding any bias in the data collection process. With these arrangements, the research environment and the manner in which the tests were administered were optimised to maximise the reliability and validity of the data. During the administration of the RSST and TWST, swallowing events were video-recorded and subsequently rated by speech and language pathologists with a minimum of five years of experience in the field of dysphagia. The raters were blinded to each other's assessments to ensure an objective evaluation.

Assessment procedure

Clinical swallowing assessment

The eating assessment tool 10 (EAT-10).

The EAT-10 is a globally used, self-administered, symptom-specific dysphagia outcome tool that has been validated for the Turkish population (27). It consists of 10 questions with a 5-point Likert scale designed to assess the severity of dysphagia and its clinical and social impact. Each question is scored from 0 to 4 (0 = no problem, 4 = severe problem). The scores for each item were summed to obtain a total score. A score of 3 or higher indicates a risk of swallowing disorder, with higher scores reflecting a greater perceived severity of dysphagia.

Repetitive Saliva Swallowing Test (RSST).

The RSST is a test used to assess swallowing control and endurance. It involves the participant swallowing as many times as possible within 30 s while seated, with the evaluator observing the larynx and counting the number of swallows. Fewer than 3 swallows in 30 s means that swallowing functions need further examination (28). Each participant was instructed to swallow as quickly and comfortably as possible. The test was timed with a stopwatch, and the number of laryngeal elevations during swallowing was counted.

The Timed Water Swallowing Test (TWST).

TWST is a simple and non-invasive method used to assess an individual's swallowing ability. The test is performed by having the person drink a standard amount of water (typically 100 or 150 ml) while timing the duration from the moment the water touches the lower lip until the last swallow, at which point the larynx returns to its resting position. During this period, the number of swallows was counted. The TWST is a highly

reliable test that can be easily administered in clinical settings (29). The validity and reliability of TWST have been established and the normative data have been pooled for the Turkish population (30). In the TWST, participants were given 100 ml of water, and the time taken to swallow the water was measured using a stopwatch while the number of swallows was counted. Any signs of coughing during the test and any cough or wet sounds after the test were noted. To calculate the average swallowing capacity (ml/s), volume per swallow (ml/swallow), and time per swallow (seconds/swallow), the total duration, number of swallows, and total amount of water consumed were recorded. If a participant was unable to finish the total amount, the remaining volume was calculated, and the total amount of water consumed was obtained by subtracting it from the initial 100 ml.

Quality of life assessment

The swallowing quality of life questionnaire (SWALL-QOL).

The SWALL-QOL measures the quality of life of individuals with swallowing disorders. It was developed by McHorney et al., and the Turkish version (T-SWAL-QOL) has been shown to be valid and reliable for the dysphagic population (31, 32). The SWAL-QOL includes 10 subscales: burden, eating time, desire to eat, food selection, communication, fear, mental health, social functioning, fatigue, and sleep. Each parameter is scored using a 5-point Likert scale. All subscales range from 0 to 100, with higher scores indicating better quality of life with respect to dysphagia (33).

Nutrition assessment

The mini nutritional assessment short form (MNA-SF).

The short form of Mini Nutritional Assessment (MNA), a widely used tool for screening and assessing malnutrition in elderly individuals, was employed in this study. The MNA-SF is considered the gold standard for assessing nutritional status (34, 35). The MNA-SF is a simple and quick screening tool designed to identify individuals at risk of or already experiencing malnutrition. It consists of six items and evaluates factors such as appetite status, acute illness and neuropsychological complaints, weight loss, mobility, and body mass index (BMI) over the past three months. The simplified Turkish version of the MNA-SF, validated by Sarıkaya, demonstrated a sensitivity of 0.94 and specificity of 0.81 (36). The total score of the MNA-SF ranged from 12 to 14 points, indicating normal nutritional status. Scores between 8 and 11 suggest a risk of malnutrition, while scores below 7 indicate malnutrition (36).

Statistical analysis

The data were analysed using IBM SPSS 25.0 software (IBM SPSS Corp., Armonk, NY, USA). This study investigated the relationship between swallowing performance and swallowing-related quality of life across the stages of AD. Frequency/percentage were used as descriptive statistics for categorical data, while mean, standard deviation, minimum, and maximum values were used for continuous data. The normality of the scores across all scales was assessed using the Shapiro-Wilk test. Since the scores follow a normal distribution, Pearson's correlation analysis was employed for the relationship analysis. The direction of the relationship was determined according to whether the Pearson correlation coefficient "r" value was positive or negative, while the strength was determined by the magnitude of the "r" value. The correlation coefficients were interpreted as follows: a very weak correlation for values between 0.05 and 0.25, a weak correlation for values between 0.26 and 0.49, a moderate correlation for values between 0.50 and 0.69, a strong correlation for values between 0.70 and 0.89, and a very strong correlation for values between 0.90 and 1.00 (37). To assess the differences between the groups, one-way ANOVA was used for more than two groups, and an independent t-test was used for comparisons between the two groups. For significant differences between the groups, Tukey's post hoc test was used to investigate which specific areas contributed to the differences. All statistical analyses were performed at a 95% confidence interval, and significance was evaluated at $p < 0.05$.

RESULTS

Participants

A total of 45 participants were included in the study. The average age of the participants was 72.84±6.97, with the youngest participant being 65 and the oldest being 91 years old. Among the participants with Alzheimer's disease, 16 (35.6%) were male and 29 (64.4%) were female. Based on the CDR scores, the participants were divided into three stages: mild, moderate, and severe Alzheimer's. Each group consisted of 15 participants. The average age of the mild-stage Alzheimer's group was 67.13±2.97 years, and the average duration of the disease was 1.73±0.88 years. In the moderate-stage Alzheimer's group, the average age was 74.13±6.52 years, and the average disease duration was 3.33±1.23 years. The average age of the severe-stage Alzheimer's group was 77.27±6.97 years, with a disease duration of 6.73±2.37 years. In the mild-stage Alzheimer's group, 86.67% of the individuals had a normal nutritional status while 33.33% were at risk of malnutrition. In the moderate-stage Alzheimer's group,

only 13.3% had a normal nutritional status, while 86.67% were at risk of malnutrition. In the severe-stage Alzheimer's group, 20% were at risk of malnutrition and 80% were malnourished. The demographic and clinical characteristics of the participants are presented in Table 1.

Table 1. Demographic and clinical characteristics of the participants with Alzheimer's disease

	CDR Stage				
	Overall (n=45)	Mild (n=15)	Moderate (n=15)	Severe (n=15)	p
Age	72.84±6.97	67.13±2.97	74.13±6.52	77.27±6.59	0.000**
Gender					
Male	16 (35.6%)	5 (33.3%)	6 (40%)	5 (33.3%)	0.908
Female	29 (64.4%)	10 (66.7%)	9 (60%)	10 (66.7%)	
Education					
Primary school	16 (35.6%)	3 (20%)	5 (33.3%)	8 (53.3%)	0.383
Secondary school	14 (31.1%)	6 (40%)	5 (33.3%)	3 (20%)	
High school	9 (20%)	5 (33.3%)	2 (13.3%)	2 (13.3%)	
University	6 (13.3%)	1 (6.7%)	3 (20%)	2 (13.3%)	
Duration of the disease (years)					
⩽ 1 Year	8 (17.7%)	8 (53.3%)	-	-	0.000**
2–4 Years	19 (48.8%)	7 (46.67%)	10 (66.7%)	2 (13.4%)	
⩾5 Years	15 (33.5%)	-	5 (33.3%)	13 (86.6%)	
MNA-SF					
· Normal nutritional status	15 (33.3%)	13 (86.67%)	2 (13.33%)	-	0.000**
· Risk of malnutrition	18 (40.0%)	2 (13.33%)	13 (86.67%)	3 (20.00%)	
· Malnourished	12 (26.67%)	-	-	12 (80.00%)	

CDR: Clinical Dementia Rating Scale, MNA-SF: Mini Nutritional Assessment Short Form *p<0.05, **p<0.01 is considered significant.

Inter-rater reliability

Two independent raters, blinded to each other's evaluations, assessed the swallowing counts from the RSST and TWST tests. The overall agreement between the raters was determined using the intraclass correlation coefficient (ICC). The ICC values and 95% confidence intervals (CIs) for the RSST and TWST scores indicated an excellent level of reliability (Table 2).

Table 2. Inter-rater reliability for swallowing counts

Number of Swallows	1st Rater	2nd Rater	ICC (95% CI)
RSST	1.61±1.73	1.64±2.02	0.94 (0.95–0.99)
TWST	2.58±1.78	2.28±2.04	0.95 (0.96-0.99)

TWST: time water swallow test, RRST: repetitive saliva swallow test

The swallowing disorders, malnutrition, and quality of life scores obtained from the clinical assessments were analysed in relation to the participants' CDR scores. The results are given in Table 3.

Table 3. Analysis of the relationship between the participants' CDR scores and swallowing disorders, malnutrition, and quality of life scores

		Total EAT-10	Total SWAL-QOL	Total RSST	Total TWST	Total MNA-SF
CDR Scores	r	.816**	-.800**	-.786**	-.728**	-.783**
	p	0.000	0.000	0.000	0.000	0.000
	n	45	45	45	45	45

CDR: Clinical Dementia Rating Scale, EAT-10: Eating Assessment Tool, TWST: Time Water Swallow Test, RSST: Repetitive Saliva Swallowing Test MNA-SF: Mini Nutritional Assessment Short Form, SWAL-QOL: Swallowing Quality of Life Questionnaire *p<0.05, **p<0.01 are considered statistically significant.

Correlation analysis was performed between the CDR scores and the total scale scores. According to the results, there is a statistically significant high positive correlation between the CDR scores and the EAT-10 scores (r=0.816; p=0.000). As the CDR scores increase, the EAT-10 scores also increase. A statistically significant high negative correlation was found between the CDR scores and the SWAL-QOL, TWST, RSST, and MNA-SF scores (r=-0.800; p=0.000, r=-0.786; p=0.000, r=-0.728; p=0.000, r=-0.783; p=0.000). As the CDR scores increased, the SWAL-QOL, TWST, RSST, and MNA-SF scores decreased. Therefore, as the severity of the disease increases, the swallowing abilities, nutritional levels, and swallowing-related quality of life decrease.

The CDR scores and swallowing disorders, malnutrition and quality of life scores obtained from the clinical evaluations of the participants were compared according to the stages of the disease, and the results are presented in Table 4.

Accordingly, a statistically significant difference was found between the EAT-10, SWAL-QOL, TWST, RSST and MNA-SF scores across the mild, moderate and severe stage groups (p=0.000). The mean EAT-10 score for all participants was 9.75±9.01. As the stage of the disease progressed, a marked increase in EAT-10 scores was observed. The average EAT-10 scores for the mild, moderate, and severe stage groups were 1.80±1.89, 7.86±3.22, and 19.60±8.10, respectively. These results suggest that as Alzheimer's progresses, the symptoms of dysphagia increase. The TWST revealed that the swallowing capacity in the mild-stage Alzheimer group was 14.93±3.56 ml, the

volume per swallow was 21.17±4.80 ml, and the duration per swallow was 1.46±0.31 seconds. As for the moderate stage, the swallowing capacity was 9.74±3.67 ml, the volume per swallow was 16.27±5.95 ml, and the duration per swallow was 1.82±0.73 seconds. For the severe stage, the swallowing capacity was 6.38±2.85 ml, the volume per swallow was 12.50±4.11 ml, and the duration per swallow was 2.11±0.48 seconds. These findings show that as the CDR scores increase, the swallowing capacity decreases and the swallowing duration increases. Likewise, the scores obtained from the RSST indicated that in the mild stage Alzheimer group, the swallowing scores for the mild, moderate, and severe stages were 7.53±2.56, 3.73±1.79, and 1.46±1.40, respectively. Accordingly, as the CDR scores increased, the number of swallows decreased. The average MNA-SF score for all participants was 9.17±3.97. As the stage of the disease progressed, a significant decrease in the MNA-SF scores was observed. The average MNA-SF scores for the mild, moderate, and severe stages were 12.50±3.40, 10.00±1.55, and 5.00±3.70, respectively. These findings show that as the disease progresses, the nutritional status of individuals deteriorates significantly.

Table 4. Comparison of the participants' swallowing disorders, malnutrition, and quality of life scores across the stages of AD

	CDR Stage				
	Overall (n=45) x̄ ±SD	Mild (n=15) x̄ ±SD	Moderate (n=15) x̄ ±SD	Severe (n=15) x̄ ±SD	p
EAT- 10	9.75±9.01	1.80±1.89	7.86±3.22	19.6±8.10	0.000**
SWAL-QOL	79.60±17.57	95.39±2.19	82.05±6.48	61.36±17.13	0.000**
TWST (100 ml)					
· Swallow capacity (ml/s)	10.35±4.82	14.93±3.54	9.74±3.67	6.38±2.85	0.000**
· Volume per swallow (ml/sw)	16.65±5.96	21.17±4.80	16.27±5.95	12.50±4.11	0.000**
· Time per swallow (s/sw)	1.79±0.59	1.46±0.31	1.82±0.73	2.11±0.48	0.000**
RSST	4.24±3.18	7.53±2.55	3.73±1.79	1.46±1.40	0.000**
MNA-SF	9.17±3.97	12.5±31.40	10.00±1.55	5.00±3.70	0.000**

CDR: Clinical Dementia Rating Scale, EAT-10: Eating Assessment Tool, TWST: Time Water Swallow Test, RRST: Repetitive Saliva Swallowing Test MNA-SF: Mini Nutritional Assessment Short Form ml/s: millilitre per second, ml/sw: millilitre per swallow; s/sw: seconds per swallow *p<0.05, **p<0.01 are considered statistically significant.

To assess which stage of AD was more affected by dysphagia, malnutrition, and quality of life, the findings regarding the evaluation criteria were compared on a group basis. The differences across the groups were analysed using the post hoc Tukey test. According to the results, the severe stage group had the lowest performance on the EAT-10, SWAL-QOL, TWST, RSST, and MNA-SF scales. Statistically significant differences were found between the mild and severe stages Alzheimer groups for EAT-10, SWAL-QOL, TWST, RSST, and MNA-SF scores (p=0.000). There was a statistically significant difference between the moderate-stage group and both the mild- and severe-stage groups in terms of the scale scores. The performance gap between the mild- and moderate-stage groups was smaller than that between the mild- and severe-stage Alzheimer groups.

The swallowing-related quality of life for participants with AD was examined according to their CDR stages, and the data for the SWAL-QOL domains are presented in Figure 1. The combined data (overall group) showed that swallowing-specific QOL was significantly affected, with average SWAL-QOL domain scores ranging from 33.1 to 93.4. Group data revealed that swallowing disorders negatively impacted the quality of life as reported by the participants, and a significant difference was observed in the total SWAL-QOL score across the mild-, moderate-, and severe-stage groups (p=0.000). In all SWAL-QOL domains, the severe-stage Alzheimer group had the lowest scores. Statistically significant differences were found across the mild-, moderate-, and severe-stage Alzheimer groups in the following subdomains: general complaints, desire to eat, eating time, frequency of symptoms, food selection, communication, fear, mental health, social, fatigue, and sleep (p<0.01).

To evaluate which stage of AD affects the quality of life the most according to the Clinical Dementia Rating (CDR), the findings related to SWAL-QOL scores were compared across groups. The differences across the groups were analysed using the post hoc Tukey test. The lowest performance across all subdomains of the SWAL-QOL subtests was observed in the severe-stage Alzheimer's group. A significant difference was found in all subdomains between the mild-stage and severe-stage groups (p<0.05). However, no statistically significant difference was observed between the mild-stage and moderate-stage groups in the subdomains of general complaint (p=0.635), desire to eat (p=0.282), symptom frequency (p=0.055), food selection (p=0.134), communication (p=0.524), fear (p=0.573), mental health (p=0.912), and social aspects (p=1.000). Similarly, no significant difference was found between the moderate-stage and severe-stage groups in the subdomains of food selection (p=0.348) and communication (p=0.139). However, a significant difference was observed in all other subdomains (p<0.05).

If quality of life was related with swallowing disorders, malnutrition, and quality of life scores obtained from clinical

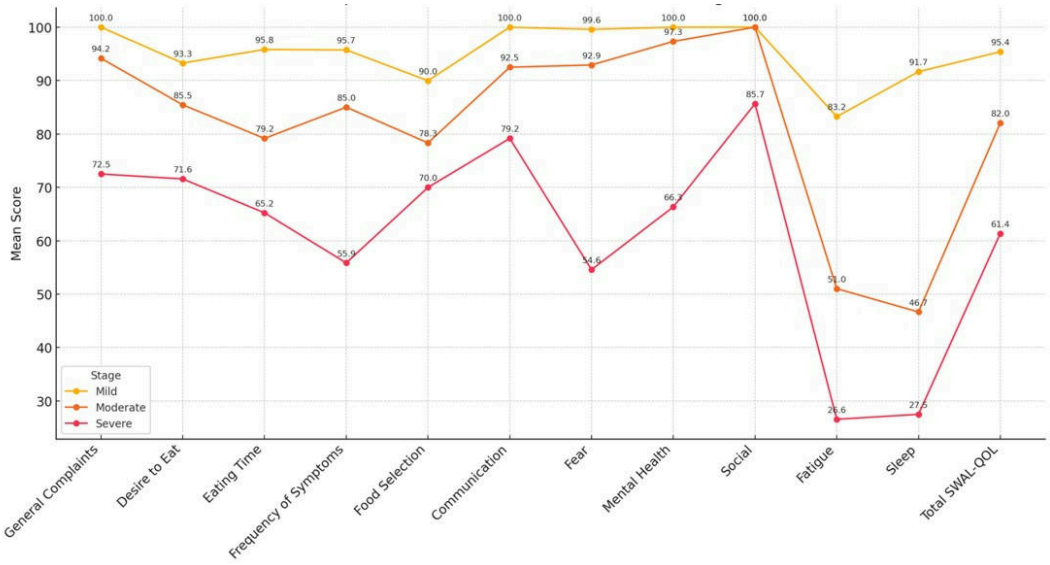


Figure 1. Comparison of SWAL-QOL scores across the stages of AD

assessments was analysed, and the results are presented in Table 5.

There was a highly significant negative correlation between the total SWAL-QOL score and the EAT-10 score (r=-0.934; p=0.000). As the SWAL-QOL score increased, the EAT-10 score decreased. Additionally, the total SWAL-QOL score showed a moderate positive correlation with the RSST and TWST scores (r=0.586; p=0.000, r=0.630; p=0.000) and a strong positive correlation with the MNA-SF score (r=0.814; p=0.000). These findings indicate that as the participants' swallowing abilities and nutritional levels improve, their swallowing-related quality of life also improves.

Table 5. Relationship between the scores of swallowing disorders and malnutrition and quality of life for individuals with AD

		EAT-10	RSST	TWST	MNA-SF
Total SWAL-QOL	r	-.934**	.586**	.630**	.814**
	p	0.000	0.000	0.000	0.000
	n	45	45	45	45

EAT-10: Eating Assessment Tool, TWST: Time Water Swallow Test, RSST: Repetitive Saliva Swallowing Test MNA-SF: Mini Nutritional Assessment Short Form, SWAL-QOL: Swallowing Quality of Life Questionnaire *p<0.05, **p<0.01 are considered statistically significant.

DISCUSSION

This study investigated the relationship between the severity of dysphagia symptoms and swallowing-related quality of life for individuals with AD across the stages of the disease. According to our findings, there is a statistically significant relationship between the CDR score and all the scales. Hence, as disease severity increased, the participants experienced greater swallowing disorders and a higher risk of malnutrition, which in turn had a more pronounced impact on their quality of life.

In our study, the EAT-10 results indicated that participants began experiencing swallowing difficulties as early as the mild stage of Alzheimer's disease. The findings also revealed that the number of participants with dysphagia increased as the disease progressed. According to the EAT-10 results, swallowing difficulty was identified in 75.56% of all the participants, 33.33% of the mild-stage participants, 93.33% of the moderate-stage participants, and 100% of the severe-stage participants. These findings demonstrate that the prevalence of swallowing difficulties increases with disease progression. The increase in EAT-10 scores as the disease becomes severe is consistent with the findings reported in the literature (3, 15). On the other hand, as the severity of the disease increases, the participants' self-reports may also be negatively affected. In patients with Alzheimer's disease, factors such as cognitive impairment, deficits in verbal communication, and loss of insight can lead to misleading responses. Therefore, in addition to patient-reported data, information from the primary caregivers is often required, especially for patients with severe-stage Alzheimer's disease. However, the question of who should be considered the primary source of information for individuals with cognitive impairment, such as Alzheimer's disease, remains unanswered (15).

Another finding of our study indicates that the swallowing duration lengthens and the swallowing capacity decreases as the disease progresses. According to the TWST results, the average swallowing capacity in the mild-stage participants was 15 ml/s, which declined to 10 ml/s in the moderate stage

and further decreased to 6 ml/s in the severe stage. Similarly, a study conducted on patients with Parkinson's disease reported an increase in swallowing duration and a decrease in TWST scores as the disease progressed, consistent with our findings (38). In line with this finding, a study on patients with Parkinsonian dementia reported that they required more time to consume a fixed volume of water compared to the age-matched control group (39). Similarly, a decrease in swallowing frequency was observed with the increase in CDR scores when examining the RSST results. Accordingly, the average swallowing frequency in the mild-stage participants was approximately 13, and it decreased to 10 in the moderate stage and further to 5 in the severe stage. A study conducted on Alzheimer's patients also found a significant decrease in RSST scores from the mild to severe stages, consistent with our findings (40). This may be related to the inability of the salivary glands to perform their functions as effectively as before due to the progression of AD, leading to a reduction in the amount of saliva in the oral and pharyngeal structures. Additionally, weakness in cognitive swallowing, atrophy in the oral and pharyngeal structures, reduced oral secretions, and insufficient sensory processing in the oral and facial regions may also be critical factors contributing to the decrease in the frequency of repeated swallows.

The risk of malnutrition significantly decreases as the disease progresses according to the MNA-SF results, which revealed that 40% of all participants with AD were at risk of malnutrition, 26.67% were malnourished, and 33.3% had a normal nutritional status. A study conducted with 76 Alzheimer's patients reported that approximately 50% of the patients were at risk of malnutrition, and 33% were already malnourished (19). Although no malnutrition was observed in the mild-stage patients in this research, the risk of malnutrition increased as the disease progressed, and the number of malnourished participants increased. No malnutrition was observed in the moderate-stage patients, while 80% of the severe-stage participants were malnourished, which agrees with others in the literature (41). A statistically significant decrease in MNA-SF scores was observed for the AD patients as the disease progressed. Consistent with the literature, our study also concluded that MNA-SF scores significantly decreased as the disease became more severe. In the later stages of AD, individuals lose their independence in nutrition, and this can negatively impact the disease prognosis when combined with issues such as difficulty in chewing and swallowing, forgetting mealtimes, and lack of appetite. Therefore, it is crucial to take necessary measures to prevent the risk of malnutrition from the early stages of AD. Providing nutritional support in the early stages, making environmental and ergonomic adjustments, and initiating family and caregiver education are effective strategies to prevent the progression of malnutrition.

The SWAL-QOL results revealed that swallowing disorders negatively impacted the quality of life as reported by the participants, and a significant difference in total SWAL-QOL scores was observed across the mild-, moderate-, and severe-stage Alzheimer groups. The severe-stage Alzheimer's group had lower scores across all SWAL-QOL subdomains, and it was found that swallowing-related quality of life decreased as AD progressed from the mild to the severe stage. Significant differences were observed across all SWAL-QOL subdomains across the mild-, moderate-, and severe-stage groups. Additionally, significant differences were determined between the mild- and severe-stage Alzheimer groups across all SWAL-QOL subdomains. However, only a limited number of subdomains (eating time, fatigue, sleep) showed significant differences between the mild- and moderate-stage groups. Between the moderate- and severe-stage groups, significant differences were found in all subdomains except for food selection and communication.

The literature is limited with respect to studies evaluating swallowing-related quality of life in patients with Alzheimer's disease. However, the results of our study align with the reported findings. Likewise, one study comparing the participants with mild to moderate AD with a healthy control group noted a parallel decline in swallowing-related quality of life corresponding to the stages of the disease, and reported that individuals with Alzheimer's scored significantly lower across all quality-of-life subdomains compared to the healthy control group (19). Furthermore, swallowing difficulties were found to have a negative impact on quality of life, particularly in areas such as general complaint, eating time, desire to eat, symptom frequency, food selection, communication, mental health, and fatigue (18). Dysphagia emerges as a significant factor negatively impacting patients' quality of life. Similar studies also highlight the negative effects of swallowing disorders on the quality of life, emphasising that these effects vary depending on the type and stage of dementia (42). Additionally, Marventano et al. noted that the severity of dementia has a definitive impact on the quality of life, while factors such as age, educational level, and general health status may also influence the quality of life (20).

However, some studies have indicated that in the severe stages of the disease, individuals find it difficult to notice changes in their quality of life due to cognitive function loss, which may result in a higher perceived quality of life (43). Hurt et al. suggested that in moderate-stage Alzheimer's patients, the increase in loss of insight may result in misleadingly

higher health-related quality of life scores (44). Another study reported that the mild-stage patients exhibited more depressive symptoms and experienced lower life satisfaction compared with the severe-stage Alzheimer's patients (45). These differences suggest that the scales assessing the quality of life are influenced by the perceptions of patients and their caregivers, and the results may vary according to their perceptions.

The literature reports varying opinions on the definition and measurement of quality of life for individuals with AD, as well as on the sources that should be trusted when assessing quality of life (46). Particularly, it is emphasised that assessing quality of life in AD is quite challenging due to impairments in cognitive functions (47). This difficulty is related to a decrease in the patients' capacity to monitor, assess, and interpret themselves. This highlights that individuals with AD may not always be a reliable source of information (43). However, the studies cited in the literature suggest that the individuals with mild and moderate cognitive impairment in AD can provide information about their subjective conditions (48, 49). Therefore, in our study, the data concerning the quality of life for individuals in the mild and moderate stages were obtained from the participants themselves, while for individuals in the severe stage, the information was gathered from the primary caregivers familiar with the patient's eating behaviours.

Early detection and management of swallowing disorders in patients with Alzheimer's disease are of great importance, and establishing regular screening programmes is essential. It is recommended to use easily applicable swallowing screening tests in clinical practice, raise awareness among patients and caregivers about signs of swallowing difficulties, and adopt a multidisciplinary approach. Additionally, monitoring patients through technological support and tele-follow-up methods, implementing appropriate nutritional modifications, and initiating rehabilitation programmes at an early stage help prevent serious complications such as aspiration. These strategies are critical for improving patients' quality of life and reducing the burden on caregivers.

Practically, healthcare professionals should routinely evaluate swallowing functions in patients with Alzheimer's disease, for example, by applying the EAT-10 or similar brief swallowing screening questionnaires every three months. Caregiver training should be provided to help recognise signs of swallowing difficulties, such as coughing, choking, or changes in voice after eating, to ensure early detection. Easily applicable swallowing screening tools save time in patient follow-up, and patients requiring an early intervention should be promptly referred to speech therapists and neurologists. Moreover, telehealth applications can be used for remote monitoring and consultation of patients receiving home care. Nutritional specialists should prepare texture-modified diet plans, and swallowing exercises suitable for patients should be started early to reduce the risk of complications.

There are some limitations to our study. First, the absence of a priori power analysis at the study design stage is a limitation, as it may affect the adequacy of the sample size and the statistical power to detect meaningful differences. Additionally, the absence of validated objective assessment tools capable of comprehensively evaluating the multiple physiological and neurological factors influencing swallowing function may have limited the internal validity of the findings. The cross-sectional design and relatively small sample size further restricted the ability to establish causal relationships and limited the generalizability of the results to broader populations. In addition, the lack of a cognitively healthy geriatric control group makes it challenging to differentiate swallowing impairments specific to AD from those associated with normal ageing processes. The significant age differences observed across the AD severity groups may have introduced additional confounding effects related to age-related physiological changes in swallowing, known as presbyphagia, complicating the interpretation of whether the observed impairments are attributable solely to neurodegenerative progression or also to normative ageing. The inability to statistically control for age as a covariate further limits the precision with which AD-specific effects on swallowing function can be isolated. Potential selection bias in the sampling may also limit the external validity and generalizability of the findings to more diverse demographic groups. Furthermore, in patients with mild and moderate AD, the absence of patient-reported swallowing data precluded direct comparisons between patient and caregiver reports. Future research incorporating both patient- and caregiver-reported outcomes is recommended to provide a more comprehensive understanding of subjective dysphagia perception, its functional impact, and implications for care optimisation. In light of these limitations, future studies should employ prospective, longitudinal designs with sufficiently powered sample sizes, include appropriate healthy control groups, integrate high-resolution objective swallowing assessments, and statistically adjust for potential covariates such as age. Such methodological refinements will allow for a more accurate delineation of the pathophysiological mechanisms underlying swallowing dysfunction in AD and contribute more robust evidence to inform clinical practice.

According to the results of our study, as the severity of AD increases, the symptoms of dysphagia and malnutrition

risks also increase. This study has shown that dysphagia begins as early as the mild stage of Alzheimer's and worsens as the disease progresses to the severe stages. Additionally, the increase in severity negatively impacts the quality of life related to swallowing function. Dysphagia is a common issue in Alzheimer's patients and has significant effects on the quality of life. This research emphasises the importance of conducting comprehensive swallowing assessments from the early stages of AD and implementing appropriate nutritional interventions that can improve food intake, eating compliance, and overall nutritional status in dysphagic individuals, thereby enhancing their quality of life.

Ethics Committee Approval	Informed written consent was obtained from all participants and the study was approved by the Ethics Committee of İstanbul Atlas University (Date: 22.07.2024, No: 46523).
Informed Consent	Written informed consent was obtained.
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Author Contributions	Conception/Design of Study- S.B.; Data Acquisition- B.M., S.B.; Data Analysis/Interpretation- S.B., B.M.; Drafting Manuscript- S.B., B.M.; Critical Revision of Manuscript- S.B.; Final Approval and Accountability- S.B., B.M; Material or Technical Support- B.M., S.B. Supervision- S.B.
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