Original Article

Association between sarcopenia and dysphagia among elderly.

Rewayda Walid Mahgoub[1], Reem Mohamed Sabry Elbedewy[1], Nirvana Gamal El Dein Hafez[2], Nermien Naim Adly[1], Mona Hegazy Mohamed[1]

1.Geriatrics and Gerontology Department, Faculty of Medicine, Ain Shams University
2. Phoniatrics unit- Faculty of medicine Ain shams university.

ABSTRACT

Background: Human aging involves a series of changes in different body systems, that result in progressive loss of function. Sarcopenia and dysphagia are common in elderly with several health outcomes related to them.
Objective: To study the association between sarcopenia and swallowing disorders among elderly.
Methods: A cross sectional study included 70 participants aged 60 or above, who were attended to Ain Shams University Hospitals from April to October 2023, collected by simple random sampling. Exclusion criteria were patients with impaired consciousness, stroke, parkinsonism, late dementia, or musculoskeletal, neurological, rheumatological disorders or hand deformity that prevented them to do the test. Sarcopenia was evaluated by skeletal muscle index and hand grip strength & defined as presence of both decreased muscle mass and impaired muscle function (strength or performance), swallowing ability was evaluated by Eating Assessment Tool (EAT-10) and Yale swallow protocol. Nutritional, functional status and comorbidities were assessed. Sensitivity, specificity, and diagnostic accuracy of EAT-10 & its association with sarcopenia were evaluated.
Results: Out of 70 participants 53 were found to be sarcopenic, 66% of sarcopenic participants were found to have dysphagia by EAT-10, and 30.2% had dysphagia by Yale swallow, EAT-10 was found to have 94.12% sensitivity, 83.02% specificity at cutoff point >5 with area under curve= 0.89 to detect dysphagia by Yale swallow protocol. Low skeletal muscle index was the strongest potential indicator of dysphagia by multivariate analysis.
Conclusion: Current study provides evidence for association between sarcopenia and dysphagia among elderly.
Key words: Sarcopenia—Swallowing disorders—elderly—EAT-10—Yale swallow.

INTRODUCTION

A progressive decrease of skeletal muscle mass, strength, and physical performance is referred to as a clinical syndrome called sarcopenia. After the age of 30, muscle mass starts to decline at a rate of 3–8% every decade, and after 70 years of age, this decline increases to 15%. [1]

In 1989, Irwin Rosenberg proposed the term ‘sarcopenia’ (Greek ‘sarx’ or flesh + ‘penia’ or loss) to describe this age-related decrease of muscle mass. [2]

The diagnosis of sarcopenia should be made based on the presence of both decreased muscle mass and impaired muscle function (strength or performance), according to the European Working Group on Sarcopenia in Older People (EWGSOP). Two criteria are used since the relationship between strength and mass is nonlinear and muscle strength is not only dependent on muscle mass. [40][3][4] Elderly people with sarcopenia have been exposed to a few un-favorable health outcomes, including higher rates of death, morbidity, and prolonged hospital stays. [2]

Swallowing disorders have been considered as a growing health concern for the elderly, being

a major cause of malnutrition, dehydration, aspiration pneumonia or even death due to asphyxiation.[5]

Given that older adults with sarcopenia may exhibit a loss of muscle mass and strength in both generalized skeletal muscles and swallowing-related muscles, the combination of sarcopenia and dysphagia has garnered significant attention in the scientific literature recently.[6]

OBJECTIVE

To study the association between sarcopenia and swallowing disorders among elderly**.**

METHODS

A cross sectional study was conducted in Ain Shams University Hospitals from April 2023 to October 2023. It involved 70 participants, who were admitted to Ain Shams University Hospitals (ASUHs) or were interviewed at the hospital clinic at the time of the study. The study included participants aged 60 or above years old, males or females, who were willing to participate in the study, collected by simple random sampling. The exclusion criteria were patients with impaired consciousness or who were uncooperative enough to participate in the study, patients diagnosed with stroke, parkinsonism, late dementia, or had musculoskeletal, neurological, rheumatological disorders or had hand deformity that prevented them to do the test.

Data collected regarding the study participants were sociodemographic characteristics, anthropometric measurements including the body mass index (BMI) (body weight [kg] divided by height [m] squared). Mid Upper Arm Circumference (MUAC) in (cm), and the Mini Nutritional Assessment Short Form (MNA-SF) [41,42], a validated nutritional screening tool with an ordinal scale ranging from 0 to 14, was utilized as indicator of nutritional status. Malnutrition, risk of malnutrition, and normal nutritional status are indicated by scores of 0–7, 8–11, and 12–14, respectively. The Mini Mental State Examination (MMSE) [43], which ranges from 0 (the most severe) to 30 (normal), is a measure of global cognitive function. The activity of daily living (ADL) [44] and instrumental activity of daily living (IADL) [45] as a measure of physical activity, ADL scale from 0 to 6, and IADL scale from 0 to 8, subjects are given categorization as independent, assisted, or dependent. Depression screening by Geriatric Depression Scale (GDS) [46], score greater than 5 suggests depression. Comorbidities assessment by Charlson comorbidity index [47], participants were categorized to have mild (1-2), moderate (3-4) and severe >=5 prognostic comorbidity index. The skeletal muscle mass was evaluated by the skeletal muscle index (SMI), which was calculated as total skeletal muscle mass (SMM), in kilogram, obtained by bioelectrical impedance analysis (BIA) [48], (Ultra life digital scale), which measures body composition, divided by height in meter squared (m2). The cut off points for muscle mass, which are based on a total skeletal muscle mass index (TSMMI), will be $\leq$ 8.5Kg/m^2 for severe sarcopenia in men and $\leq$5.75kg/m^2 for severe sarcopenia in women, as well as $\leq$10.75kg/m^2 for moderately reduced muscle mass in men and $\leq$6.75kg/m^2 for moderately reduced muscle mass in women. Handheld dynamometer [49] (Jamar Hydraulic hand dynamometer; 5030J1, USA), a hand-grip test instrument, was used to evaluate muscle strength which is measured in kilograms. Low muscle strength was defined as hand grip strength less than 30 kg in men and 20 kg in women. With the use of a 10-item Eating Assessment Tool (EAT-10) [50], swallowing ability was assessed. This short questionnaire asks about the exact symptoms of dysphagia. It is formed of ten items, and each one is rated from 0 (no difficulty) to 4. (Severe problem)**.** A total score of 3 or more is defined as abnormal swallowing function. The Yale swallow protocol [51], an easily given, reliable, and validated swallow screening tool, including a 3-ounce water swallow challenge, a quick cognitive assessment, and an oral mechanism examination. The test indicates to continuously drink 3 ounces (90 cc) of water straight out of a cup. Coughing during or up to one minute after finishing the task or a moist, hoarse voice quality after swallowing suggested failure to pass the test that needed to

be referred for objective dysphagia testing. Passing this protocol permitted successful, appropriate, and timely oral diet recommendations to be made without the need for further objective dysphagia testing for the vast majority of hospitalized patients regardless of their admitting diagnoses.

Data were gathered via simple random sampling of patients who were either admitted to ASUHs or interviewed at the hospital clinic following the approval of the study methodology by the Research Review Board and the MASRI ethical committee of the Department of Geriatrics and Gerontology Medicine, Faculty of Medicine, Ain Shams University. Participants' privacy and confidentiality were guaranteed.

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 27. The quantitative data were presented as mean, standard deviations and ranges when parametric and median, inter-quartile range (IQR) when data found non-parametric. Also, qualitative variables were presented as number and percentages. The comparison between groups regarding qualitative data was done by using ***Chi-square test*** and/or ***Fisher exact test*** when the expected count in any cell found less than 5. The comparison between two independent groups with quantitative data and parametric distribution was done by using ***Independent t-test*** while with nonparametric distribution were done by using ***Mann-Whitney test. Spearman correlation coefficients*** were used to assess the correlation between two quantitative parameters in the same group. ***Receiver operating characteristic curve (ROC)*** was used to assess the best cut off point with its sensitivity, specificity, positive predictive value, negative predictive value and area under curve (AUC) of the studied marker. Uni-variate and Multivariate logistic regression analysis was used to assess predictors with their odds ratio (OR) and 95% CI. The confidence interval was set to 95%. So, the p-value was considered significant at the level of <0.05.

RESULTS

A total of 70 elderly participants who were admitted to Ain Shams University Hospitals or interviewed at the hospital clinic during the study were included. Table (1) summarizes the sociodemographic characteristics of all 70 individuals. The mean age of the participants was 72.13 ± 6.90, 52.9% were men. As regards the medical history of the participants, 15.7% were smokers and 71.4% were non-smokers, 42.9% were diabetics, 62.9% were hypertensives, DM and HTN were the most frequent diseases. 95.7% of the study subjects were receiving medications, 54.3% were on one medication.

As regards Geriatric syndromes (cognitive impairment, falls, incontinence, and depression) 60.0% of the participants didn't experience any of these syndromes, 34.3% had only one syndrome, the most frequent was fall (25.7%).

In the current study, dementia was excluded by MMSE, 51.4% of the participants were malnourished, functional status represented by ADL median 6 and IQR from 4 to 6 and by IADL median 5 and IQR from 3 to 8. It also shows that 15.7% of the participants showed positive screening for depression by GDS. Table (2) shows that the mean skeletal muscle mass (SMM) (kg) of the participants was 18.71 ± 3.31 SD for males and 16.67 ± 2.72 SD for females, the mean SMI (skeletal muscle mass divided by height square) (kg/m2) was 6.79 ± 1.20 SD for males and 6.78 ± 1.21 SD for females, mean muscle power of the participants was 15.54 ± 6.71 SD for males and 11.35 ± 3.53 SD for females, mean muscle rate (SMM adjusted to total body weight) was 0.34 ± 0.03 SD for males and 0.27 ± 0.04 SD for females. The majority of the participants (97.1%) had moderate or severe prognostic comorbidity index which indicate poor prognosis, only 2 patients (2.86%) had mild prognostic comorbidity index. This table illustrate that 57.1% of the participants had altered swallowing ability by EAT-10 assessment, while only 24.3% of the participants were found to have altered swallow by Yale swallow protocol assessment.

Table (3) shows that 62.3% of the sarcopenic participants were males with a highly statistically significant difference with females with P-value =0.005. As regards anthropometric measures, there was high statistically significant association between lower body mass index and sarcopenia. It also shows that 60.4% of the participants were retired with statistically significant association with sarcopenia.

In this study 24.5% of the sarcopenic participants had heart failure, and there is statistically significant association between sarcopenia and heart failure with P-value=0.024. Among the study participants, sarcopenic patients show statistically high significant association with Charlson comorbidity index score and 98.1% of the sarcopenic subjects had significant association with moderate to severe prognostic comorbidity index.

Table (4) shows sarcopenic participants had statistically high significant association with altered swallowing ability by EAT-10 questionnaire and statistically significant association with altered swallowing ability evaluated by Yale swallow protocol.

In the current study, there is statistically significant association between lower body mass index (BMI) and altered swallowing ability by EAT-10 assessment with $p<0.036$. Other studied sociodemographic data were statistically insignificant. There was no statistically significant association between altered swallowing by EAT-10 and any of the studied medical history of the study participants.

Table (5) shows that participants with altered swallowing by EAT-10 assessment had statistically significant association with lower IADL score and had statistically significant association with poor nutritional status (malnourished) assessed by MNA-SF. Also, this table shows that there is statistically highly significant relation between assessment of swallowing disorders by EAT-10 questionnaire and Yale swallow protocol assessment with P-value < 0.001.

The ROC curve shows that the best cutoff point for EAT-10 score to differentiate between patients with and without dysphagia according to Yale Swallow protocol was found > 5 with sensitivity of 94.12%, specificity 83.02% and area under curve (AUC) of 0.893.

Table (6) The univariate logistic regression analysis shows that all previous significant factors were found to be statistically significantly associated with altered swallowing function assessed by EAT-10 assessment, except for MNA score was not significantly associated. and the multivariate regression analysis shows that the most important indicators of the abnormal swallowing function by EAT-10 are SMI and MUAC.

The current study shows that there is statistically significant association between altered swallowing ability assessed by YALE swallow protocol and lower BMI with P-value = 0.035, and statistically significant association with the height of the study participants with P-value 0.046. Other studied sociodemographic were statistically insignificant.

There was no any statistically significant association between altered swallowing ability assessed by YALE swallow protocol and the medical history of the participants in the current study.

Table (7) shows that there is statistically highly significant association between lower IADL score and altered swallowing ability assessed by YALE swallow protocol, and had statistically significant association with poor nutritional status (malnourished) assessed by MNA-SF. This table also shows that statistically highly significant relation between high EAT-10 assessment and YALE swallow protocol.

Table (8) The univariate logistic regression analysis shows that all previous significant factors were found to be statistically significantly associated with altered swallowing function assessed by YALE swallow protocol, with highly significant association with SMI. Also, the multivariate logistic regression analysis shows that the most important predictors associated with altered swallowing ability by YALE swallow assessment were SMI and EAT-10 score>5.

Table (1): Sociodemographic characteristics and anthropometric measurements of the participants:

		Total No. = 70
Gender	Male	37 (52.9%)
	Female	33 (47.1%)
Age (Years)	Mean ± SD	72.13 ± 6.90
	Range	60 – 95
Weight (kilogram)	Mean ± SD	58.97 ± 11.71
	Range	40 – 102.7
Height (meter)	Mean ± SD	1.62 ± 0.08
	Range	1.45 – 1.86
BMI (kg/m2)	Mean ± SD	22.20 ± 4.39
	Range	16 – 40.1
MUAC (cm)	Mean ± SD	22.22 ± 3.55
	Range	17 – 38
Marital state	Single	3 (4.3%)
	Married	43 (61.4%)
	Widow	22 (31.4%)
	Divorced	2 (2.9%)
Education	Illiterate Primary school	43 (61.4%) 8 (11.4%)
	Secondary school	7 (10.0%)
	High education	12 (17.1%)
Occupation	Retired Still working	37 (52.9%) 3 (4.3%)
	Were not working	30 (42.9%)
Income	Satisfactory	49 (70.0%)
	Unsatisfactory	21 (30.0%)
Living	Alone	9 (12.9%)
	With another person	61 (87.1%)

*****_BMI: body mass index, MUAC: mid upper arm circumference_

Table (2): Assessment of muscle mass, muscle power, swallowing disorders, and the prognostic comorbidity index:

		Total No. = 70 **Male no.=37, Female no.= 33**
SMM (Kg)		
Male Female	Mean ± SD (Range)	18.71 ± 3.31 (11 – 24.9) 16.67 ± 2.72 (12 – 22.1)
Assessment of muscle mass (SMI) kg/m2 Male Female	Mean ± SD (Range)	 6.79 ± 1.20 (4.15 – 9.49) 6.78 ± 1.21 (4.93 – 9.99)
Assessment of muscle power (hand grip) kg Male Female	Mean ± SD (Range)	 15.54 ± 6.71 (5 – 35) 11.35 ± 3.53 (5 – 18.33)
Muscle rate Male Female	Mean ± SD (Range)	 0.34 ± 0.03(0.27 – 0.44) 0.27 ± 0.04 (0.15 – 0.34)
Assessment of swallowing disorders By EAT-10 score	No problem <3 Altered swallowing>=3	30 (42.9%) 40 (57.1%)
EAT score	Median (IQR)	4 (0 – 8)
	Range	0 – 27
CCI score	Median (IQR)	4 (3 – 6)
	Range	2 – 13
Prognostic comorbidity index	Mild (1-2) Moderate (3-4)	2 (2.9%) 35 (50.0%)
	Severe >= 5	33 (47.1%)
Assessment of swallowing disorders By YALE swallow protocol	Pass Fail	53 (75.7%) 17 (24.3%)

*****_SMM: skeletal muscle mass, SMI: skeletal muscle index, CCI: Charlson comorbidity index, EAT-10: Eating Assessment Tool._

Table (3): Relation between sarcopenia and sociodemographic characteristics and anthropometric measurements of participants:

		No Sarcopenia	Sarcopenia	Test value	P-value	Sig.
		No. = 17	No. =53			
Gender	Male Female	4 (23.5%) 13 (76.5%)	33 (62.3%) 20 (37.7%)	7.750*	0.005	**HS**
Age (years)	Mean ± SD	70.35 ± 6.97	72.70 ± 6.85	-1.224•	0.225	NS
	Range	61 – 85	60 – 95			
Weight (kg)	Mean ± SD Range	64.61 ± 15.06 46 – 102.7	57.17 ± 9.92 40 – 81.2	2.353•	0.022	**S**
Height (meter)	Mean ± SD	1.58 ± 0.08	1.63 ± 0.08	-2.422•	0.018	**S**
	Range	1.45 – 1.69	1.45 – 1.86			
BMI (kg/m2)	Mean ± SD Range	25.29 ± 5.95 20.1 – 40.1	21.21 ± 3.24 16 – 31.25	3.618•	0.001	**HS**
Marital state	Single Married Widow	1 (5.9%) 9 (52.9%) 7 (41.2%)	2 (3.8%) 34 (64.2%) 15 (28.3%)	1.717*	0.633	NS
	Divorced	0 (0.0%)	2 (3.8%)			
Education	Illiterate Primary school Secondary school	12 (70.6%) 1 (5.9%) 0 (0.0%)	31 (58.5%) 7 (13.2%) 7 (13.2%)	3.690*	0.297	NS
	High education	4 (23.5%)	8 (15.1%)			
Occupation	Retired Still working	5 (29.4%) 2 (11.8%)	32 (60.4%) 1 (1.9%)	6.601*	0.037	**S**
	Not working	10 (58.8%)	20 (37.7%)			
Income	Satisfactory	13 (76.5%) 4 (23.5%)	36 (67.9%) 17 (32.1%)	0.448*	0.503	NS
	Unsatisfactory					
Living	Alone With another person	3 (17.6%) 14 (82.4%)	6 (11.3%) 47 (88.7%)	0.460	0.498	NS

BMI: body mass index

*P-value > 0.05: Non- significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant *: Chi-square test; •:*
Independent t-test

Table (4): Relation between sarcopenia and dysphagia:

		No Sarcopenia	Sarcopenia	Test value	Pvalue	Sig.
		No. = 17	No. =53			
Assessment of swallowing disorders by EAT-10 assessment	No problem <3	12 (70.0%)	18 (34%)	7.050*	0.008	HS
	Altered swallowing>=3	5 (29.4%)	35 (66%)			
Assessment of swallowing disorders by YALE swallow protocol	Pass	16 (94.1%)	37 (69.8%)	4.136*	0.042	S
	Fail	1 (5.9%)	16 (30.2%)			

EAT-10: Eating Assessment Tool.

Table (5): Relation between assessment of swallowing disorders by EAT-10 assessment and functional, nutritional, depression, comorbidity index and swallowing disorders by YALE swallow protocol:

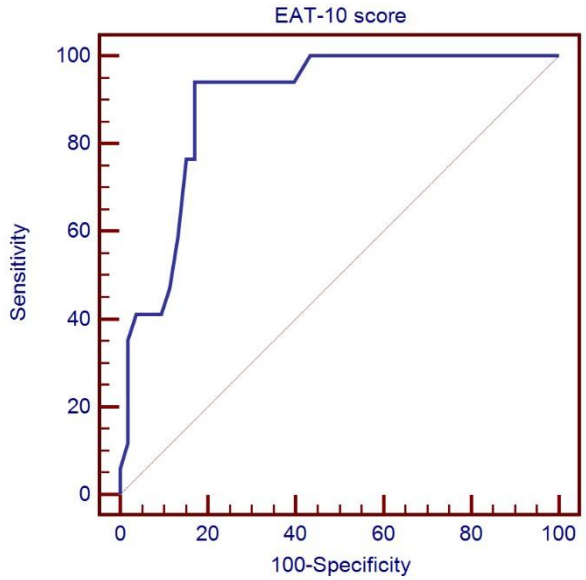
		No problem	Altered swallowing	Test value	Pvalue	Sig.
		No. = 30	No. = 40			
ADL score	Median (IQR)	6 (4 – 6)	6 (4 – 6)	-0.272‡	0.786	NS
	Range	2 – 6	2 – 6			
IADL score	Median (IQR)	7 (3 – 8)	4 (3 – 6)	-2.117‡	0.034	S
	Range	3 – 8	2 – 8			
Nutrition assessment	12-14= normal nutritional state	4 (13.3%)	5 (12.5%)	7.915*	0.019	S
	8-11 = at risk of malnutrition	16 (53.3%)	9 (22.5%)			
	0-7 = malnutrition	10 (33.3%)	26 (65%)			
MNA score	Median (IQR)	9 (6 – 11)	6.5 (5.5 – 10)	-1.710‡	0.087	NS
	Range	4 – 14	3 – 13			
Assessment of depression	1-4 = negative	24 (80%)	35 (87.5%)	0.728*	0.394	NS
	>=5 = positive	6 (20%)	5 (12.5%)			
Prognostic comorbidity index	Mild (1-2)	0 (0%)	2 (5%)	2.128*	0.345	NS
	Moderate (3-4)	17 (56.7%)	18 (45%)			
	Severe >=5	13 (43.3%)	20 (50%)			
Assessment of swallowing disorders by Yale swallow protocol	Pass	30 (100%)	23 (57.5%)	16.840*	0.000	HS
	Fail	0 (0%)	17 (42.5%)			

**MUAC: mid upper arm circumference, ADL: activity of daily living, IADL: instrumental activity of daily living, MNA: mini nutritional assessment.*

P>0.05: Non -significant (NS); P <0.05: Significant (S); P <0.01: Highly significant (HS)

*: Chi-square test; •: Independent t-test; ‡: Mann-Whitney test

Figure (1): Receiver operating characteristic (ROC) curve for EAT-10 score to detect swallowing disorders assessed by Yale score among the studied patients.



ROC curve of EAT-10 score to detect swallowing disorders

Cut off point	AUC	Sensitivity	Specificity	+PV	-PV
>5	0.893	94.12	83.02	64.0	97.8

Table (6): Univariate and multivariate logistic regression analysis for factors associated with EAT 10 score:

		Univariate			Multivariate (Backward-Wald)			
	P-value	Odds ratio (OR)	95% C.I. for OR		P-value	OR	95% C.I. for OR	
			Lower	Upper			Lower	Upper
BMI ≤ 18.59 kg/m2	**0.040**	5.310	1.079	26.135	-	-	-	-
IADL ≤ 6	**0.010**	4.000	1.393	11.485	-	-	-	-
MNA	0.061	1.954	0.970	3.934	-	-	-	-
SMM ≤ 18 kg	**0.001**	6.152	2.164	17.486	-	-	-	-
SMI ≤ 6.39 kg/m2	**0.000**	12.176	3.165	46.852	**0.004**	7.847	1.916	32.135
MUAC ≤ 21 cm	**0.001**	6.667	2.219	20.028	**0.032**	3.747	1.118	12.554

MUAC: mid upper arm circumference, ADL: activity of daily living, IADL: instrumental activity of daily living, MNA: mini nutritional assessment, SMM: skeletal muscle mass, SMI: skeletal muscle index, BMI: body mass index.

Table (7): Relation between assessment of swallowing disorders by YALE swallow protocol assessment and functional, nutritional, depression, and comorbidity index:

		Assessment of swallowing disorders		Test value	P-value	Sig.
		Pass	Fail			
		No. = 53	No. = 17			
ADL score	Median (IQR) Range	6 (5 – 6) 2 – 6	4 (3 – 6) 2 – 6	-1.733‡	0.083	NS
IADL score	Median (IQR) Range	6 (4 – 8) 3 – 8	3 (3 – 4) 2 – 8	-3.704‡	0.000	**HS**
Nutrition assessment	12-14= normal nutritional state 8-11 = at risk of malnutrition	9 (17%) 22 (41.5%)	0 (0%) 3 (17.6%)	9.114*	0.010	**S**
	0-7 = malnutrition	22 (41.5%)	14 (82.4%)			
MNA score	Median (IQR) Range	9 (6 – 11) 3 – 14	6 (5 – 7) 4 – 11	-2.298‡	0.022	**S**
Assessment of depression	1-4 = negative >=5 = positive	46 (86.8%) 7 (13.2%)	13 (76.5%) 4 (23.5%)	1.035*	0.309	NS
EAT score	Median (IQR) Range	2 (0 – 5) 0 - 23	9 (8 – 20) 3 - 27	-4.913‡	0.000	**HS**
CCI score	Median (IQR) Range	4 (3 – 6) 3 - 13	5 (3 – 7) 2 - 8	-0.721‡	0.471	NS
Prognostic comorbidity index	Mild (1-2) Moderate (3-4)	1 (1.9%) 28 (52.8%)	1 (5.9%) 7 (41.2%)	1.229*	0.541	NS
	Severe >=5	24 (45.3%)	9 (52.9%)			

ADL: activity of daily living, IADL: instrumental activity of daily living, MNA: mini nutritional assessment, EAT: eating assessment tool, CCI: Charlson comorbidity index.

Table (8): Univariate and multivariate logistic regression analysis to assess predictors of swallowing disorders according to Yale swallow protocol:

	Univariate				Multivariate			
	P-value	Odds ratio (OR)	95% C.I. for OR		P-value	Odds ratio (OR)	95% C.I. for OR	
			Lower	Upper			Lower	Upper
BMI <= 18.59 kg/m2	**0.010**	5.483	1.515	19.849	–	–	–	–
Fall	**0.005**	5.500	1.670	18.117	–	–	–	–
IADL score <= 5	**0.003**	24.381	3.004	197.893	–	–	–	–
MNA score <= 7	**0.007**	6.576	1.685	25.656	–	–	–	–
SMM <= 17.5 kg	**0.002**	8.351	2.127	32.781	–	–	–	–
Assessment of muscle mass <= 6.35 kg/m2	**0.000**	90.000	10.424	777.063	**0.001**	130.792	7.662	223.616
Assessment of muscle power <= 10 kg	**0.012**	4.396	1.391	13.894	–	–	–	–
MUAC <= 20 cm	**0.048**	3.134	1.011	9.714	–	–	–	–
EAT score >5	**0.000**	78.222	9.169	667.346	**0.001**	114.521	6.642	197.704

IADL: instrumental activity of daily living, BMI: body mass index, MUAC: mid upper arm circumference, EAT: eating assessment tool, SMM: skeletal muscle mass, MNA: mini nutritional assessment.

DISCUSSION

The present study indicated that sarcopenia was disproportionately common among men compared with women (62.3 percent in men versus 37.7 percent in women). This finding was consistent with comparable conclusions from other studies, including ***Pongchaiyakul, et al***, ***Gallagher and Delegge, et al.,*** *and* ***Landi et al.,*** [7] [8] [9]

Gallagher and Delegge, et al., [8] stated that men are more likely to have sarcopenia than women due to their higher rate of muscular atrophy, which was supported by ***Gallagher et al.,*** [10] 's findings of a greater absolute loss of skeletal muscle mass in men than in women.

A study by ***Baumgartner et al.*** [11] stated that among people older than 80 years males exhibited a higher prevalence of sarcopenia. The mechanisms leading to absolute gender differences in muscle reduction with increasing age are unknown, although hormonal factors are most likely involved (growth hormone, sex steroids, and insulin like growth factor).

Malnourished older people are more likely to develop sarcopenia due to decreased muscular protein synthesis. Furthermore, poor dietary protein consumption is related with a higher loss of lean mass in community-dwelling older people, indicating a significant link between malnutrition and sarcopenia as stated by ***Boirie, et al.,*** [12] ***and Houston, D. K., et al.,*** [13]

In the current study, participants with sarcopenia and altered swallowing ability were found to have statistically significant association with lower body mass index (BMI), which is a simple and commonly used measurement to evaluate malnutrition worldwide. ***Yalcin et al.,*** [14] found that sarcopenic individuals tend to have lower BMI due to loss of mass and function in whole-body skeletal muscles and swallowing muscles. ***Togashi et al.,*** [15] stated that, in patients with dysphagia and a BMI < 20.0 kg/m2, clinicians should suspect the possibility of sarcopenic dysphagia.

Dysphagia patients who are malnourished and do not have access to adequate treatment and

therapies have a longer hospital stay, higher risk of complications, and a higher mortality rate than those who are properly nourished. [16] Therefore, dysphagia and malnutrition are closely associated.[17] The prevalence of concurrent malnutrition and dysphagia has been estimated between 3% and 29%. [18]

The results of the current study demonstrated a statistically significant relationship with (P-value = 0.019) between impaired swallowing ability measured by EAT-10 assessment and the poor nutritional status as determined by the mini nutritional assessment-short form (MNA-SF), as well as a statistically significant relationship with (P-value = 0.01) with dysphagia measured by the Yale swallow protocol. The univariate regression analysis was used to confirm the link between malnutrition and dysphagia assessed by Yale swallow test.

Like these findings, ***Wakabayashi et al.,*** [19] stated that 56.7% were at risk of dysphagia based on EAT-10. This group of patients showed higher rates of malnutrition as judged by the MNA-SF test (88.2 percent vs. 48.7 percent; p = 0.001) and mortality (70 percent vs. 35.9 percent; p = 0.001), and ***Maeda et al.,*** [20] revealed that lower BMI was associated with a higher frequency of swallowing abnormalities at discharge among older patients who did not have swallowing difficulties.

The current study found that the Charleson comorbidity index (CCI) was found to be an indicator for sarcopenia with a high statistically significant difference, that the more comorbid conditions accumulated, the more frequent the occurrence of sarcopenia, and that 98.1 percent of sarcopenic participants had a moderate or severe prognostic comorbidity index.

Gong et al., [21] found an independent link between comorbidity and skeletal muscle mass/physical performance in adults aged 65 years and older. This shows that the CCI score plays a significant role in assessing skeletal muscle mass and physical performance, which could help clinicians identify sarcopenia.

According to ***Lardiés-Sánchez, et al.,*** [22] a loss of muscle mass and strength has been connected to variety of chronic health issues, including diabetes mellitus and end-stage organ disorders. The main explanation that connects these long-term illnesses to sarcopenia is the potential causal role of chronic inflammation in the pathophysiology of the disease itself.

This study demonstrated that there was no statistically significant correlation between the overall comorbidity score and dysphagia. This was the same result of ***Maeda et al.,*** [23] who found that age, sex, and Charlson's comorbidity index, were not significantly worse in the dysphagia group than in the non-dysphagia group.

Pacifico, et al., [24] stated that sarcopenia is highly prevalent in individuals with cardiovascular diseases, dementia, diabetes mellitus and respiratory disease. This matched with what was found in this study as cardiovascular diseases were more common in sarcopenic participants than non-sarcopenic participants.

The majority of earlier researchers found that sarcopenia has an impact on functional status and that older persons with severe sarcopenia are roughly two to five times more likely than older adults with normal muscle mass to have functional impairment or disability as stated by ***Yalcin et al.,*** [14] and ***Alva, Velázquez et al.,***[25]. A physical impairment would compel one to engage in less physical activity, which would reduce the stimulation received by skeletal muscle. This vicious cycle could eventually result in considerable muscular atrophy.

This was not in concordance with the results in the current study which showed that there was no statistically significant difference between sarcopenic individuals and non-sarcopenic individuals in the functional status assessed by ADL and IADL, also ***janssen, et al.,*** [26] did not find a strong connection between sarcopenia and functional disability and stated that a number of other factors, such as nutrition, inflammation, hormonal changes, and protein turnover, may also be involved in sarcopenia, disability, and the relationship between them. Therefore, more research is required to examine the connection between functional impairment, sarcopenia, and the concomitant conditions.

This was similar to the finding of ***Baumgartner, et al.,*** [27] who reported that in a sample of 451 senior men and women from New Mexico, sarcopenia in the absence of obesity (76 percent of the sarcopenic group) was not a major risk factor for functional impairment.

Instrumental activity of daily living (IADL) evaluates function at a higher level than activity of daily living (ADL). ***Igarashi, et al.,*** [28] found that elderly with poor oral intake function, whether in hospitals or institutions or even living in communities were likely to have poor physical functions and malnutrition.

In the current study functional disability assessed by IADL was found to be statistically significant with altered swallowing ability assessed by EAT-10 and Yale swallow protocol, this is consistent with findings of ***Yang, et al.,*** [29] who stated that dysphagia was associated with impairment in the IADL activities of preparing meals and taking medication.

This could be explained by the fact that sarcopenia can be brought on by inactivity. For example, hospital-associated deconditioning, which is prevalent in elderly patients, can worsen underlying sarcopenia by further reducing physical activity. Consequently, dysphagia may result from advanced sarcopenia, and dysphagia and functional impairment are related. [23]

Numerous studies have previously shown a connection between sarcopenia and dysphagia, presumably because the development of sarcopenia may also affect the swallowing muscles [30][31]. ***Zhao et al.,*** [32] conducted a meta-analysis and determined that older sarcopenic individuals had a 4.06 odds ratio for dysphagia. As a result, dysphagia was noted in sarcopenic individuals who did not have a clear neurological condition; thus, the term "sarcopenic dysphagia."

In the present study, there was statistically significant association between sarcopenia and dysphagia assessed by EAT-10 and Yale swallow protocol among the study subjects. A useful clinical description and diagnostic standards for sarcopenia were presented by EWGSOP in 2010. They stated that the amount and function of muscle are the criteria of sarcopenia, and the measurable variables are physical performance, strength, and mass. [33]

The current study showed that reduced skeletal muscle mass (SMM), lower skeletal muscle index (SMI), and decreased mid upper arm circumference (MUAC) were statistically significantly associated with altered swallowing function assessed by EAT-10 questionnaire and Yale swallow protocol by the univariate regression analysis, while the multivariate regression analysis showed that decreased SMI was the strongest potential indicator of dysphagia. This was similar to the finding of ***Maeda, et al.,***[23]

Kuroda and Kuroda, et al., [34] found that, according to the results of the water swallowing test, there was a relation between dysphagia and arm circumference which is a measure of muscle mass. ***Andrade, et al.,*** [35] found that lower values of calf circumference and arm circumference were significant in the risk group of dysphagia according to EAT-10 assessment.

This was in concordance with what was found in the present study, that MUAC was found to be statistically significantly associated with altered swallowing ability assessed by EAT-10 questionnaire by the univariate regression analysis and the multivariate regression analysis proved it to be one of the most potential indicators for dysphagia by EAT-10.

Reduced muscle mass impairs the capacity to swallow since it is expected for the swallowing muscles to experience a generalized loss of muscle mass. Additionally, because the pharyngeal muscle mass is diminished, the pharyngeal lumen size increases, making swallowing difficult, as noted by ***Molfenter, et al.,*** [36]

It has been shown that elderly people with sarcopenia have weaker swallowing muscles. In numerous research on the elderly, hand grip strength has been utilized as a substitute measurement for whole-body muscle strength. Age-associated declines in hand grip strength and decline in swallowing function-associated tongue pressure were remarkably similar. [37] Accordingly, estimation of swallowing function can be achieved through the application of grip strength assessment based

on sarcopenia criteria, as mentioned by ***Okada, Yamaguchi, et al.,*** [38]

This is similar to what was found in the present study that, lower hand grip strength was statistically significantly associated with dysphagia, but it was not the most specific indicator for dysphagia according to Yale swallow protocol by multivariate regression analysis.

A self-administered survey tool for the subjective evaluation of dysphagia is called the EAT-10. An EAT-10 score of three or more is considered abnormal, according to normative data. Excellent criterion-based validity, test-retest repeatability, and internal consistency have all been demonstrated by the instrument. [39]

The present study investigated the agreement for the risk of dysphagia in the same individual, between the self-administered EAT-10 questionnaire and the bedside Yale Swallow Protocol. It was found that, the best cut off value of EAT-10 questionnaire score of the studied participants was >5 points at which altered swallowing ability was detected and confirmed by Yale swallow protocol assessment with sensitivity 94.12%, specificity 83.02% and area under curve=0.89 which indicates high diagnostic accuracy.

The EAT-10 was found to be statistically highly significantly related to Yale swallow protocol at the cutoff point >5 and the multivariate analysis found it to be one of the most potential indicators for dysphagia by Yale swallow protocol.

Two significant results about evidence for sarcopenic dysphagia were presented in the current study. First, one possible risk factor for dysphagia is a decrease in skeletal muscle mass. Second, sarcopenia-related variables including diet and physical activity, in addition to muscle mass, may be thought of as predicting factors for dysphagia. With these things in mind, sarcopenic dysphagia was the term used to describe the dysphagia that was seen in the study.

CONCLUSION

Current study provides evidence for association between sarcopenia and dysphagia among elderly and risk factors for sarcopenic dysphagia and detected the diagnostic accuracy and best cutoff point of EAT-10 to detect dysphagia by Yale swallow protocol. Preventive and therapeutic interventions require further studies.

REFERENCES

1. *Vandewoude MF, Alish CJ, Sauer AC, Hegazi RA. Malnutrition-sarcopenia syndrome: is this the future of nutrition screening and assessment for older adults?. Journal of aging research. 2012 Oct;2012.*

2. *Rosenberg IH. Sarcopenia: origins and clinical relevance. The Journal of nutrition. 1997 May 1;127(5):990S-1S.*

3. *Goodpaster BH, Park SW, Harris TB, Kritchevsky SB, Nevitt M, Schwartz AV, Simonsick EM, Tylavsky FA, Visser M, Newman AB. The loss of skeletal muscle strength, mass, and quality in older adults: the health, aging and body composition study. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2006 Oct 1;61(10):1059-64.*

4. *Janssen I, Baumgartner RN, Ross R, Rosenberg IH, Roubenoff R. Skeletal muscle cutpoints associated with elevated physical disability risk in older men and women. American journal of epidemiology. 2004 Feb 15;159(4):413-21.*

5. *Logrippo S, Ricci G, Sestili M, Cespi M, Ferrara L, Palmieri GF, Ganzetti R, Bonacucina G, Blasi P. Oral drug therapy in elderly with dysphagia: between a rock and a hard place!. Clinical interventions in aging. 2017 Jan 31:241-51.*

6. *Wakabayashi H. Presbyphagia and Sarcopenic Dysphagia: Association between Aging, Sarcopenia, and Deglutition Disorders. The Journal of frailty & aging. 2014 Jan 1;3(2):97-103.*

7. *Pongchaiyakul C, Limpawattana P, Kotruchin P, Rajatanavin R. Prevalence of sarcopenia and associated factors among Thai population. Journal of bone and mineral metabolism. 2013 May;31:346-50.*

8. *Gallagher D, DeLegge M. Body composition (sarcopenia) in obese patients: implications for care in the intensive care unit. Journal of Parenteral and Enteral Nutrition. 2011 Sep;35:21S-8S.*

9. *Landi F, Liperoti R, Fusco D, Mastropaolo S, Quattrociocchi D, Proia A, Russo A, Bernabei R, Onder G. Prevalence and risk factors of sarcopenia among nursing home older residents. Journals of*

Gerontology Series A: Biomedical Sciences and Medical Sciences. 2012 Jan 1;67(1):48-55.

10. *Gallagher D, Ruts E, Visser M, Heshka S, Baumgartner RN, Wang J, Pierson RN, Pi-Sunyer FX, Heymsfield SB. Weight stability masks sarcopenia in elderly men and women. American Journal of Physiology-Endocrinology and Metabolism. 2000 Aug 1;279(2):E366-75.*

11. *Baumgartner RN, Wayne SJ, Waters DL, Janssen I, Gallagher D, Morley JE. Sarcopenic obesity predicts instrumental activities of daily living disability in the elderly. Obesity research. 2004 Dec;12(12):1995-2004.*

12. *Boirie Y, Morio B, Caumon E, Cano NJ. Nutrition and protein energy homeostasis in elderly. Mechanisms of ageing and development. 2014 Mar 1;136:76-84.*

13. *Houston DK, Nicklas BJ, Ding J, Harris TB, Tylavsky FA, Newman AB, Lee JS, Sahyoun NR, Visser M, Kritchevsky SB, Health ABC Study. Dietary protein intake is associated with lean mass change in older, community-dwelling adults: the Health, Aging, and Body Composition (Health ABC) Study. The American journal of clinical nutrition. 2008 Jan 1;87(1):150-5.*

14. *Yalcin A, Aras S, Atmis V, Cengiz OK, Varli M, Cinar E, Atli T. Sarcopenia prevalence and factors associated with sarcopenia in older people living in a nursing home in A nkara T urkey. Geriatrics & gerontology international. 2016 Aug;16(8):903-10.*

15. *Togashi S, Wakabayashi H, Ohinata H, Nishioka S, Kokura Y, Momosaki R. Sensitivity and specificity of body mass index for sarcopenic dysphagia diagnosis among patients with dysphagia: A multi-center cross-sectional study. Nutrients. 2022 Oct 26;14(21):4494.*

16. *Allard JP, Keller H, Jeejeebhoy KN, Laporte M, Duerksen DR, Gramlich L, Payette H, Bernier P, Vesnaver E, Davidson B, Teterina A. Malnutrition at hospital admission—contributors and effect on length of stay: a prospective cohort study from the Canadian Malnutrition Task Force. Journal of Parenteral and Enteral Nutrition. 2016 May;40(4):487-97.*

17. *Popman A, Richter M, Allen J, Wham C. High nutrition risk is associated with higher risk of dysphagia in advanced age adults newly admitted to hospital. Nutrition & Dietetics. 2018 Feb;75(1):52-8.*

18. *Namasivayam-MacDonald AM, Morrison JM, Steele CM, Keller H. How swallow pressures and dysphagia affect malnutrition and mealtime outcomes in long-term care. Dysphagia. 2017 Dec;32:785-96.*

19. *Wakabayashi H, Matsushima M. Dysphagia assessed by the 10-item eating assessment tool is associated with nutritional status and activities of daily living in elderly individuals requiring long-term care. The journal of nutrition, health & aging. 2016 Jan;20:22-7.*

20. *Maeda K, Ishida Y, Nonogaki T, Shimizu A, Yamanaka Y, Matsuyama R, Kato R, Mori N. Development and predictors of sarcopenic dysphagia during hospitalization of older adults. Nutrients. 2019 Dec 26;12(1):70.*

21. *Gong G, Wan W, Zhang X, Liu Y, Liu X, Yin J. Correlation between the Charlson comorbidity index and skeletal muscle mass/physical performance in hospitalized older people potentially suffering from sarcopenia. BMC geriatrics. 2019 Dec;19:1-8.*

22. *Lardiés-Sánchez B, Sanz-París A, Pérez-Nogueras J, Serrano-Oliver A, Torres-Anoro ME, Cruz-Jentoft AJ. Influence of nutritional status in the diagnosis of sarcopenia in nursing home residents. Nutrition. 2017 Sep 1;41:51-7.*

23. *Maeda K, Takaki M, Akagi J. Decreased skeletal muscle mass and risk factors of sarcopenic dysphagia: a prospective observational cohort study. Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences. 2017 Sep 1;72(9):1290-4.*

24. *Pacifico J, Geerlings MA, Reijnierse EM, Phassouliotis C, Lim WK, Maier AB. Prevalence of sarcopenia as a comorbid disease: A systematic review and meta-analysis. Experimental gerontology. 2020 Mar 1;131:110801.*

25. *Alva MD, Camacho ME, Velázquez JD, Lazarevich I. The relationship between sarcopenia, undernutrition, physical mobility and basic activities of daily living in a group of elderly women of Mexico City. Nutricion hospitalaria. 2013;28(2):514-21.*

26. *Janssen I. Influence of sarcopenia on the development of physical disability: the Cardiovascular Health Study. Journal of the American Geriatrics Society. 2006 Jan;54(1):56-62.*

27. *Baumgartner RN, Wayne SJ, Waters DL, Janssen I, Gallagher D, Morley JE. Sarcopenic obesity predicts instrumental activities of daily living disability in the elderly. Obesity research. 2004 Dec;12(12):1995-2004.*

28. *Igarashi K, Kikutani T, Tamura F, Yajima Y, Tohara T. Factors predicting the effects of dysphagia rehabilitation on multidimensional functional status in elder outpatients: A prospective cohort study. Gerodontology. 2020 Sep;37(3):271-8.*

29. *Yang EJ, Kim MH, Lim JY, Paik NJ. Oropharyngeal dysphagia in a community-based elderly cohort: the Korean longitudinal study on health and aging. Journal of Korean medical science. 2013 Oct 1;28(10):1534-9.*

30. *Fujishima I, Fujiu-Kurachi M, Arai H, Hyodo M, Kagaya H, Maeda K, Mori T, Nishioka S, Oshima F, Ogawa S, Ueda K. Sarcopenia and dysphagia: position paper by four professional organizations. Geriatrics & gerontology international. 2019 Feb;19(2):91-7.*

31. *Wakabayashi H, Kishima M, Itoda M, Fujishima I, Kunieda K, Ohno T, Shigematsu T, Oshima F, Mori T, Ogawa N, Nishioka S. Diagnosis and treatment of sarcopenic dysphagia: a scoping review. Dysphagia. 2021 Jun;36:523-31.*

32. *Zhao WT, Yang M, Wu HM, Yang L, Zhang XM, Huang Y. Systematic review and meta-analysis of the association between sarcopenia and dysphagia.*

The journal of nutrition, health & aging. 2018 Oct;22:1003-9.

33. *Shetty BC. Study of prevalence of pulmonary hypertension among non-dialysis and dialysis dependent chronic kidney disease patients (Doctoral dissertation, Rajiv Gandhi University of Health Sciences (India)).*

34. *Kuroda Y, Kuroda R. Relationship Between Thinness and Swallowing Function in J apanese Older Adults: Implications for Sarcopenic Dysphagia. Journal of the American Geriatrics Society. 2012 Sep;60(9):1785-6.*

35. *Andrade PA, Santos CA, Firmino HH, Rosa CD. The importance of dysphagia screening and nutritional assessment in hospitalized patients. Einstein (Sao Paulo). 2018 Jun 7;16.*

36. *Molfenter SM, Amin MR, Branski RC, Brumm JD, Hagiwara M, Roof SA, Lazarus CL. Age-related changes in pharyngeal lumen size: a retrospective MRI analysis. Dysphagia. 2015 Jun;30:321-7.*

37. *Sugaya N, Goto F, Okami K, Nishiyama K. Association between swallowing function and muscle strength in elderly individuals with dysphagia. Auris Nasus Larynx. 2021 Apr 1;48(2):261-4.*

38. *Okada T, Yamaguchi H, Tanaka S, Koyama K, Hishida A, Konno S, Nakamura M, Sugiura H, Nishida Y. Hand Grip Strength Assessment Based on Sarcopenia Diagnostic Criteria Predicts Swallowing Function. Dysphagia. 2023 Jul 28:1-8.*

39. *Belafsky PC, Mouadeb DA, Rees CJ, Pryor JC, Postma GN, Allen J, Leonard RJ. Validity and reliability of the Eating Assessment Tool (EAT-10). Annals of Otology, Rhinology & Laryngology. 2008 Dec;117(12):919-24.*

40. *Cruz-Jentoft, A. J., Landi, F., Topinková, E., & Michel, J. P. (2010). Understanding sarcopenia as a geriatric syndrome. Current Opinion in Clinical Nutrition & Metabolic Care, 13(1), 1-7.*

41. *Murphy, M. C., Brooks, C. N., New, S. A., & Lumbers, M. L. (2000). The use of the Mini-Nutritional Assessment (MNA) tool in elderly orthopaedic patients. European journal of clinical nutrition, 54(7), 555-562.*

42. *Abd-Al-Atty, M. F., Abou-Hashem, R. M., & Abd Elaziz, K. M. (2012). Prevalence of malnutrition in recently hospitalized elderly in Cairo using a valid and reliable short form of Arabic version of Mini-Nutritional Assessment (MNA-SF-A). Middle East Journal of Age and Ageing, 9(4), 8-12.*

43. *Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. Journal of psychiatric research, 12(3), 189-198.*

44. *Katz, S., Ford, A. B., Moskowitz, R. W., Jackson, B. A., & Jaffe, M. W. (1963). Studies of illness in the aged: the index of ADL: a standardized measure of biological and psychosocial function. jama, 185(12), 914-919.*

45. *Siriwardhana, D. D., Walters, K., Rait, G., Bazo-Alvarez, J. C., & Weerasinghe, M. C. (2018). Cross-cultural adaptation and psychometric evaluation of the Sinhala version of Lawton Instrumental Activities of Daily Living Scale. PLoS One, 13(6), e0199820.*

46. *Sheikh, J. I., & Yesavage, J. A. (2014). Geriatric Depression Scale (GDS): recent evidence and development of a shorter version. In Clinical gerontology (pp. 165-173). Routledge.*

47. *Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. Journal of chronic diseases, 40(5), 373-383.*

48. *Janssen, I., Heymsfield, S. B., Baumgartner, R. N., & Ross, R. (2000). Estimation of skeletal muscle mass by bioelectrical impedance analysis. Journal of applied physiology, 89(2), 465-471.*

49. *Roberts, H. C., Denison, H. J., Martin, H. J., Patel, H. P., Syddall, H., Cooper, C., & Sayer, A. A. (2011). A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age and ageing, 40(4), 423-429.*

50. *Belafsky, P. C., Mouadeb, D. A., Rees, C. J., Pryor, J. C., Postma, G. N., Allen, J., & Leonard, R. J. (2008). Validity and reliability of the Eating Assessment Tool (EAT-10). Annals of Otology, Rhinology & Laryngology, 117(12), 919-924.*

51. *Leder, S. B., & Suiter, D. M. (2014). The Yale Swallow Protocol. An Evidence-Based Approach to Decision Making. Switzerland: Springer International Publishing.*