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ASSOCIATION BETWEEN DYSPHAGIA AND FRAILTY IN COMMUNITY DWELLING OLDER ADULTS

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Abstract: *Objectives:* Dysphagia is described as a geriatric syndrome that occurs more frequently with aging. It is associated with the deterioration in functionality however, it is usually ignored. Frailty is a geriatric syndrome that is recognized more with its well-known adverse consequences. Very recently, dysphagia has been suggested to accompany frailty in older adults. We aimed to investigate the association between dysphagia and frailty in the community dwelling older adults. *Design:* Prospective, cross-sectional study. *Setting:* Geriatric outpatient clinic. *Participants:* Older adults aged ≥60 years. *Measurements:* Dysphagia was evaluated by EAT-10 questionnaire and frailty by FRAIL scale. Handgrip strength (HGS) was evaluated by hand-dynamometer. Gait speed was evaluated by 4-meter usual gait speed (UGS). Nutritional status was assessed by mini-nutritional assessment-short form (MNA-SF). *Results:* 1138 patients were enrolled. Mean age was 74.1±7.3 years. EAT-10 questionnaire was answered by all and FRAIL-scale by 851 subjects. EAT-10 score >15 points was regarded as significant dysphagia risk. The participants with EAT-10>15 points were older when compared to the participants with EAT-10<=15 points (p=0.002). Among participants with EAT-10>15 points, women gender and neurodegenerative diseases were more prevalent (p=0.04, p=0.002; respectively); number of chronic diseases, number of drugs and FRAIL score were higher (p=0.001 for each), and HGS, UGS, MNA-SF scores were lower (p=0.002, p=0.01, p<0.001; respectively). In multivariate analyses, the factors independently associated with presence of EAT-10 score>15 were FRAIL score and the number of drugs. *Conclusion:* Dysphagia is associated with frailty irrespective to age, presence of neurodegenerative diseases, number of chronic diseases and drugs. To our knowledge, this is the largest serie in the literature providing data on independent association of dysphagia with frailty.

Key words: Dysphagia, frailty, older adult, EAT-10, FRAIL, hand grip strength.

Introduction

Effective and safe swallowing is one of the basal requirements to sustain life. It is well-known that age-related changes occur by ageing defined as presbyphagia (1). Many factors contribute to presbyphagia including the decrease in saliva production, dental problems, decrease in sensitivity of the oral mucosa and pharynx, decrease in compensatory capacity of the brain and loss of muscle mass and function as well. These factors increase the susceptibility to dysphagia and may act as a precipitating factor (2). That is, presbyphagia increases the risk of developing dysphagia in the older adult. Dysphagia is a symptom that is defined as difficulty or discomfort in the propogation of the alimentary bolus from mouth to stomach. The difficulty may be related to transfer of the bolus from mouth to esophagus and/or from esophagus to stomach. Hence, dysphagia may develop due to oropharyngeal and/or esophageal problem (3). The prevalence of dysphagia increases with ageing. Some authors suggest that oropharyngeal dysphagia is a pandemic threat in the 21st century (4). The prevalence of dysphagia differs according to the study setting and screening/diagnostic techniques. The prevalence in community-living older adults was reported between 11.4-33.7% by screening questionnaire, 23% by clinical exploration (i.e volume viscosity swallowing test) (5). The prevalence in institutionalized older adults was reported as 40% (5). Dysphagia is multifactorial with diverse etiological factors and associated with multiple comorbidities. It is associated with deterioration in functionality, malnutrition, infections, mortality but usually ignored and can only be treated with multi-faceted management so that it fulfills the features of a geriatric syndrome (6-9). It is possible that identification of risk factors in the older adult would aid in the risk factor prevention/management thereby decreasing dysphagia incidence and outcomes. Additionally, determine the associations of dysphagia can facilitate recognition of dysphagia in the presence of those associations.

Frailty is a geriatric syndrome that is recognized more than dysphagia with its well-known adverse consequences among older adults. Frailty is characterized by decline in multiple body functions and reduced physical reserve (10). Multiple frailty assessment tools have been developed to identify frail patients (11) including but not limited to the Fried physical frailty phenotype, frailty index, Rockwood clinical frailty scale and FRAIL scale. Fried frailty phenotype and the frailty index assessments are the most commonly cited approaches to assess frailty. However, they need more time and/or advanced techniques. Using a quicker frailty screening assessment tool is easier and more convenient for the clinicians and researchers. FRAIL scale is an example of such a tool that takes only minutes to perform and does not require advanced measurement (12). The frailty data obtained from the FRAIL questionnaire

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is also consistent with the clinical findings (13). Very recently, dysphagia has been put forward to accompany frailty or its components (i.e. low hand grip strength, gait speed) (14-17). These studies are limited with their low number of participants. We aimed to investigate the association between dysphagia and frailty in a large group of community dwelling older adults. The FRAIL questionnaire was preferred in our study because it is practical, easy to apply and compatible with the clinical findings.

Material and methods

This is a prospective, cross-sectional study, performed between July 2015-September 2016 in geriatric outpatient clinic of our university hospital. The participants of 60 years of age or older were consecutively recruited. Patients with acute problems or minimental state examination score <24 were excluded. Informed consent was obtained from all participants. Dysphagia screening was performed by EAT-10 questionnaire (18). The questionnaire inquires about all aspects of dysphagia i.e oropharyngeal, esophageal, liquid or solid dysphagia. EAT-10 consists of 10 questions pointed from 0 to 4. For each question, 0 indicates no problem and 4 indicates severe problem. Accordingly, higher scores are suggestive of swallowing problem. For our study, we defined individual EAT-10 question as positive if the score for that question was noted >= 1. For the total EAT-10 score, two different thresholds are identified. EAT-10 score >=3 is denoted as positive screening, EAT-10 score>15 is denoted as significantly related to aspiration risk (19).

Frailty was assessed by FRAIL scale (12). It consists 5-items evaluating fatigue, resistance, ambulation, illnesses, and loss of weight. It is scored 0 to 5 and higher scores are suggestive for frailty. The FRAIL scale scores of 0, 1-2 and 3-5 refer to robustness, prefrailty and frailty, respectively. Hand grip strength (HGS) was evaluated by Jamar hydraulic hand dynamometer. It was measured while sitting with the elbow at 90° flexion and wrist in the neutral position. Subjects exerted their maximum grip strength with bilateral hands. After three trials were performed with both hands, the maximum exerted grip strength was noted as the HGS. Population specific cut-offs (i.e. 32 kg in men and 22 kg women) already defined by our group were used (20). Usual gait speed was determined while the participants were walking 4 m with usual speed and low usual gait speed is defined as <=0.8 m/s (21). Basic and instrumental activities of daily living (ADL, IADL) were evaluated by the modified Katz and Lawton ADL scales (22). The scores for each item were determined as 1, 2, and 3 if the patient was totally dependent, partially dependent and independent for the activity, respectively. The ADL total scores <=6, 7–12 and 13–18 points and IADL total scores <=8, 9–16 and 17–24 points refer to dependency, partial dependency, and independency, respectively (22). Nutritional status was assessed by mini nutritional assessment-short form (MNA-SF). Age, sex, history of neurodegenerative disease (i.e. stroke, dementia, Parkinson's disease), number of chronic diseases and number of drugs taken on regular daily basis were noted with face-to-face interview and from the medical files. Informed consent was signed by all participants. The study was approved by the Ethics Committee in Istanbul University Istanbul Medical Faculty.

Statistical analysis

The continuous variables were investigated for normality. Numerical variables were given as mean ± standard deviation for normally distributed variables and as median for skew-distributed variables. Categorical variables were noted as frequencies. Two groups were compared with independent sample t-test or Mann Whitney U test as necessary. The variables that were found significant in univariate analyses were analysed with binary logistic and linear regression analyses. Multicollinearity was checked and the variables which have multicollinearity in between were not analysed in the same regression models. The multicollinearity among the possible regression analyses independent variables were checked with Pearson, Spearman or Kendall's tau-b correlation analyses. We defined multicollinearity was present if the r >=0.8 in between the possible independent variables p values less than 0.05 were accepted as significant. SPSS (statistical package for social sciences) for Windows 21.0 program was used for data analyses.

Results

A total of 1138 patients were enrolled with a mean age of 74.1± 7.3 years. 348 (30.6 %) was men and 790 (69.4%) was women. EAT-10 questionnaire was answered by all participants and FRAIL scale by 851 subjects. Among all participants, 57.2% men and 66.6% women was scored more than 3 at EAT-10 questionnaire. EAT-10 score was higher than 15 in 3.4% of men and 8.1% of the women. The prevalences of frailty and prefrailty were 19.5% and 42.6% in men vs 32.5% and 46.5% in women. The characteristics of the study population are given in Table 1.

Univariate analyses

The participants with EAT-10>15 points were older when compared to the participants with EAT-10<=15 points (p=0.002). Among participants with EAT-10>15 points, women gender and neurodegenerative diseases were more prevalent (p=0.04, p=0.002; respectively); number of chronic diseases, number of drugs and FRAIL score were higher (p=0.001 for each), and HGS, UGS, MNA-SF scores were lower (p=0.002, p=0.01, p<0.001; respectively) (Table 2).

In participants with EAT-10>3 points, women gender and neurodegenerative diseases were more prevalent (p<0.001, p=0.002; respectively); number of chronic diseases, number of drugs and FRAIL score were higher (p=0.003, p=0.001, p=0.001; respectively), and HGS, UGS, MNA-SF scores were

Table 1
Characteristics of the study population

Variable	Men (n=348)	Women (n=790)	p
Age (years)	75.4±7.1	73.5±7.3	<0.001
BMI (kg/m2)	28.0±4.2	30.7±5.7	<0.001
Number of diseases	3.6±2 (3)	3.7±1.9 (4)	0.4
Number of drugs	5.7±3.3 (5)	6.0±3.1 (5)	0.1
Neurodegenerative disease	7.7%	15.9%	0.8
HGS (kg)	34.1±7.9	22.2±5.9	<0.001
Low HGS	36.1%	39.7%	0.4
UGS (m/s)	0.98±0.27 (1)	0.89±0.26 (0.89)	<0.001
Low UGS	23.1%	36.3%	0.005
MNA-SF score	12.4±2.1	12.1±1.8	0.1
Nutritional Status			0.5
Normal	74.2%	71.6%	
Undernutrition (MN or MNR)	25.8%	28.4%	
EAT-10 score	4.4±5.2	5.9±6.2	<0.001
EAT-10 score>=3	57.2%	66.6%	
EAT-10 score>15	3.4%	8.1%	
FRAIL score	1.2±1.2 (1)	1.8±1.3 (1)	<0.001
Frailty			<0.001
Normal	37.9%	21.1%	
Prefrail	42.6%	46.5%	
Frail	19.5%	32.5%	
EAT-10 QUESTIONS (positive)*			
My swallowing problem has caused me to lose weight.	9.2%	8%	0.5
My swallowing problem interferes with my ability to go out for meals.	4.3%	7.5%	0.047
Swallowing liquids takes extra effort.	52%	56%	0.2
Swallowing solids takes extra effort.	32.5%	44.3%	<0.001
Swallowing pills takes extra effort.	29.6%	39.9%	0.001
Swallowing is painful.	7.5%	14.3%	0.001
The pleasure of eating is affected by my swallowing.	10.6%	14.8%	0.06
When I swallow food sticks in my throat.	44.5%	56.6%	<0.001
I cough when I eat.	41.7%	51.3%	0.003
Swallowing is stressful.	11.2%	21.1%	0.001

Data are given as mean±standard deviation (median) or percentage (%) as appropriate; HGS: hand grip strength; UGS: usual gait speed; MNA-SF: mini nutritional assessment-short form; MN: malnutrition; MNR: malnutrition risk; *For each EAT-10 question, it is defined as positive if the score for that question was answered as >=1

lower (p=0.001, p=0.03, p<0.001; respectively).

Multivariate analyses

Three different regression analyses were run. The independent variables were same for all three regression analyses and were as follows: age, sex, presence of neurodegenerative disease, number of chronic diseases and drugs, HGS, UGS, MNA-SF score and FRAIL score. No multicollinearity was detected in between the independent variables.

For the first regression analysis: Dependent variable was the presence of EAT-10 score>15. In this analysis, the only factor independently associated with presence of EAT-10 score>15 was FRAIL score [p=0.004, odds ratio=1.67] (Table 3).

Second regression analysis: Dependent variable was the presence of EAT-10 score>=3. In this analysis, the only factors independently associated with presence of EAT-10 score>=3 were FRAIL score [p=0.01, odds ratio=1.28] and the number of

Table 2
Univariate analyses results for EAT-10 score> 15 points

Variable	EAT-10 score<=15 points	EAT-10 score> 15 points	p
Age	74±7.3	75.9± 8.3	0.002
Sex (Female/Male)	91.9%/ 96.5%	8.1%/ 3.5%	0.04
Neurodegenerative disease	5%	15.2%	0.002
Number of diseases	3.6±1.9	4.4±2	0.001
Number of drugs	5.8±3.1	7.6±3.5	0.001
FRAIL score	1.5±1.3	3.0±1.0	0.001
Hand grip strength	26.3±8.6	21.2±8.0	0.002
Usual gait speed	0.92±0.26	0.75±0.24	0.01
MNA-SF score	12.2±1.9	11.0±2.4	<0.001

MNA-SF: mini nutritional assessment-short form

Table 3
Binary logistic regression analysis results for the presence of EAT-10 score>15

Variable	p	Odds ratio [Exp(B)]	95% Confidence Interval
Age	0.45	0.967	0.886- 1.054
Sex	0.7	1.456	0.238- 9.782
Neurodegenerative diseases	0.28	0.438	0.123- 1.814
Number of diseases	0.72	0.935	0.664- 1.344
Number of drugs	0.08	1.220	0.974- 1.515
HGS	0.34	0.941	0.835- 1.066
UGS	0.77	0.658	0.061- 9.491
MNA-SF	0.90	1.00	0.784- 1.297
*FRAIL score	0.04	1.673	1.016- 2.709

*Significant association; HGS: hand grip strength; UGS: usual gait speed; MNA-SF: mini nutritional assessment-short form

regularly used drugs [p=0.02, odds ratio=1.14] (Table 4).

Third regression analysis: Dependent variable was EAT-10 score. In this analysis, the only factors independently associated with EAT-10 score were FRAIL score [p<0.001, Beta=0.203] and the number of regularly used drugs [p=0.01, Beta=0.195] (Table 5).

Discussion

We found that dysphagia screened by EAT-10 questionnaire was associated with frailty independent of age, sex, presence of neurodegenerative diseases, number of chronic diseases, drugs, HGS, UGS and nutritional status.

In the very recent years, dysphagia has been put forward to accompany frailty (14-17). First, in 2014, Hathaway et al. (14) enrolled consecutive 183 patients in an outpatient swallowing clinic setting to test whether objective measurements of frailty could help identify patients at risk for dysphagia. They included grip strength, and gait speed as measures of frailty and assessed dysphagia by instrumental swallowing examination. Although they found relationship between hand grip strength and dysphagia in the univariate analysis, multivariate analysis did not substantiate this relationship. Similarly, they reported that gait speed was not associated with dysphagia while ambulatory status was significantly associated with dysphagia. They argued that their study may be confounded by the fact that the study was performed in an outpatient setting for swallowing disorders. A high proportion of the patients had dysphagia related to other causes than frailty. In this study, more than 1/3 of the study patients' diagnosis is head and neck cancer. In such patients, severity of dysphagia is likely disproportionate to their overall conditioning. Notably, they reported that the analysis performed excluding those patients revealed stronger associations between the frailty markers and dysphagia. They also pointed out that most severely frail patients are likely to present in acute care or nursing facilities or may be homebound and frailty associated dysphagia would be likely encountered much more frequently in these settings. Accordingly, they suggested the relationship between frailty and dysphagia deserves further investigation and frailty assessments may help

Table 4
Binary logistic regression analysis results for the presence of EAT-10 score>= 3

Variable	p	Odds ratio [Exp(B)]	95% Confidence Interval
Age	0.65	0.992	0.956- 1.023
Sex	0.9	0.961	0.545- 1.822
Neurodegenerative diseases	0.63	1.174	0.702- 2.418
Number of diseases	0.13	0.883	0.754- 1.044
*Number of drugs	0.02	1.142	1.023- 1.271
HGS	0.22	0.977	0.943- 1.015
UGS	0.89	0.884	0.398- 2.858
MNA-SF	0.80	0.98	0.883- 1.117
*FRAIL score	0.01	1.282	1.039- 1.520

*Significant association; HGS: hand grip strength; UGS: usual gait speed; MNA-SF: mini nutritional assessment-short form

Table 5
Linear regression analysis results for EAT-10 score

Variable	p	B	Std. Error	Beta	95% Confidence Interval for B
Age	0.12	-0.050	0.04	-0.08	(-0.12) - 0.02
Sex	0.57	-0.294	0.62	-0.031	(-1.51) – 0.92
Neurodegenerative diseases	0.96	0.181	0.63	0.014	(-1.06) – 1.43
Number of diseases	0.25	-0.193	0.16	-0.089	(-0.51) – 0.12
*Number of drugs	0.01	0.270	0.1	0.196	0.07 – 0.47
HGS	0.52	-0.270	0.04	-0.05	(-0.10) – 0.05
UGS	0.86	-0.459	0.99	-0.027	(-2.42) – 1.5
MNA-SF	0.11	-0.200	0.12	-0.083	(-0.43) – 0.03
*FRAIL score	<0.001	0.203	0.19	0.211	0.39 – 1.14

Note: R2=0.126 (p<0.001; *Significant association; HGS: hand grip strength; UGS: usual gait speed; MNA-SF: mini nutritional assessment-short form

identify whom those at risk for complications of dysphagia. In 2015, this group (15) studied prevalance of dysphagia among 14 patients intubated more than 12 hours following cardiac surgery with low handgrip strength. Handgrip strength was measured and in case of the detection of low grip strength, patients underwent clinical swallowing exam performed by a speech-language pathologist and then to a modified barium swallow (MBS). 86% of tested patients had low handgrip strength. Eight patients with low grip strength completed the bedside swallowing exam and MBS, and they revealed that dysphagia was prevalent among those with low HGS. In the 2016 systematic review, Madhavan et al. (16) studied the risk factors associated with dysphagia (swallowing disorders) in the community dwelling older adults. They included 15 studies composed of 14 cross-sectional and 1 prospective cohort study. They reported that among the high quality studies, four risk factors were reported as significantly associated with dysphagia i.e. history of clinical disease like stroke, age > 70 years, depression and physical frailty (23). The study providing evidence on the association of dysphagia and frailty which had evaluated the frailty by the HGS measure. Nevertheless, they noted that identification of specific risk factors for dysphagia was premature, yet. Lastly, in 2017, Melgaard et al. (17). explored the relationship between oropharyngeal dysphagia (OD), and frailty among patients hospitalized for community acquired pneumonia. In this study, frailty was indicated by combined efforts of factors i.e. functional status, increased comorbidity, HGS, dementia and admission from the nursing home. In a total of 154 consecutive patients, they reported that there was a significant difference according to all of the frailty parameters they have considered except for comorbidity between patients with and without OD. Patients with OD had lower functional status, lower HGS and had more prevalent to dementia and admission origin as nursing home.

All these aforementioned studies are limited by their relatively low number of participants. Additionally, vast majority of studies were only focused on some components of the frailty i.e. such as hand grip strength and/or gait speed (14-17). The most recent study by Melgaard et al. evaluated frailty more in detail by combined efforts of factors i.e. functional

status, increased comorbidity, HGS, dementia and admission from the nursing home (17). However, this model was even not a documented model for evaluation of frailty.

Our study is a cross-sectional study. Therefore, we can not suggest a definitive cause-result association. In one view, frailty may cause dysphagia. Impaired muscle function is a well-known factor to cause dysphagia (14). Decline in tongue strength has a clinical relevance with respect to dysphagia development. The correlation between tongue strength and grip strength (23) as well as other measures of physical strength including jump height and power has been established (24). Alternatively, dysphagia may cause frailty because it is likely to impair the nutritional status, muscle function and cause recurrent aspiration pneumonia (25-26). Most likely, these two views are both valid and there seems to be a reciprocal, synergistic relationship between frailty and dysphagia (14); Hence, a vivid cycle can easily induce between dysphagia and frailty, and no matter which one starts first, they seem to increase each other. Therefore, these findings suggest that detection of dysphagia should promote evaluation for frailty and the vice versa is also true.

Our study has some strengths and limitations. We have included 1138 patients which represents the largest study on association of dysphagia and frailty. We evaluated dysphagia and frailty by valid tools as EAT-10 and FRAIL tools. EAT-10 is generated by Belafsky et al. in 2008 (18). Its validity was assessed by evaluating between healthy individuals and patients already diagnosed with dysphagia. It was found that EAT-10 tool may be used to document the initial dysphagia severity and monitor the treatment response in persons with a wide array of swallowing disorders as well (18). FRAIL tool was presented by Morley et al. in 2012. Crossectionally, it correlated significantly with IADL difficulties, short physical performance battery, grip strength and one-leg stand among participants with no baseline ADL difficulties. Additionally, in longitudinal analyses, being pre-frail or frail at baseline significantly predicted future ADL difficulties and mortality in subjects compared with no baseline ADL difficulties and/or dependencies. It is a simple and an excellent screening test for clinicians to identify frail persons (13). So, both our dysphagia tool and frailty tool are proved clinical relevance. However, it should also be considered that both tools are screening tools -not diagnostic tools. Another point is that, this was a cross-sectional study therefore no cause-effect relationship could be stated. In fact, it seems that frailty and dysphagia seem to potentiate each other.

In conclusion, our study showed that dysphagia screened by EAT-10 tool was independently associated with frailty screened by the FRAIL scale irrespective of age, sex, presence of neurodegenerative diseases, number of chronic diseases and drugs, HGS, UGS and nutritional status. We suggest that frailty should be a component of evaluation in older adults with dysphagia and dysphagia should be a component of evaluation in patients with frailty. This approach may aid in identifying patients with otherwise unrecognized dysphagia and frailty. Management of frailty and dysphagia may contribute to the management of each of these common geriatric syndromes.

Conflict of Interest: The authors have no conflicts.

Sponsor's role: None

Ethical standard: The authors declare that the study procedures comply with current ethical standards for research involving human participants in Turkey. The study protocol had been approved by Istanbul University, Istanbul Medical School Ethics Committee.

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References

1. Robbins J, Hamilton JW, Lof GL et al (1992) Oropharyngeal swallowing in normal adults of different ages. Gastroenterology1992;103.3:823-9.
2. Muhle P, Wirth R, Glahn J et al (2015) Age-related changes in swallowing. Physiology and pathophysiology. Nervenarzt. 2015;86:440-51.
3. Rofes L, Arreola V, Almirall J et al (2011) Diagnosis and management of oropharyngeal dysphagia and its nutritional and respiratory complications in the elderly. Gastroenterol Res Pract, 2011. http://dx.doi.org/10.1155/2011/81899
4. Ortega O, Martín A, Clavé P (2017) Diagnosis and management of oropharyngeal dysphagia among older persons, state of the art. J Am Med Dir Assoc. 2017;18.7:576-582.
5. Halter JB, Ouslander JG, Studenski S et al (2017) Hazzard's Geriatric Medicine and Gerontology, 7rd Edition. McGraw-Hill Education; JoAnne Robbins, 2017.
6. Cabre M, Serra-Prat M, Force LL et al (2014) Oropharyngeal dysphagia is a risk factor for readmission for pneumonia in the very elderly persons: observational prospective study. J Gerontol A Biol Sci Med Sci. 2014;69: 330–7.
7. Baijens LWJ, Clave P, Cras P et al (2016) European Society for Swallowing Disorders–European Union Geriatric Medicine Society white paper: oropharyngeal dysphagia as a geriatric syndrome. Clin Interv Aging.2016;11:1403.
8. Cruz-Jentoft AJ, Baeyens JP, Bauer JM et al (2010) Sarcopenia: European consensus on definition and diagnosis. Age Ageing. 2010;39:412–23.
9. Flacker JM. (2003) What is a geriatric syndrome anyway? J Am Geriatr Soc. 2003;51:574-6.
10. Yilmaz O, Aykent B, Kucukdagli P, et al (2019) Frailty is associated with multimorbidities due to decreased physical reserve independent of age. Eur J Intern Med. 2019;61:e12-3. https://doi.org/10.1016/j.ejim.2019.01.017
11. Walston JD(2018) Frailty. Uptodate. https://www.uptodate.com/contents/frailty?search=frailty&source=search_result&selectedTitle=1~124&usage_type=default&display_rank=1 Accessed 23 February 2019.
12. van Kan GA, Rolland YM, Morley JE et al (2008) Frailty: toward a clinical definition. J Am Med Dir Assoc. 2008;9:71-2.
13. Morley JE, Malmstrom TK, Miller DK (2012) A simple frailty questionnaire (FRAIL)predicts outcomes in middle aged African Americans. J Nutr Health Aging.2012;16:601-8.
14. Hathaway B, Vaezi A, Egloff AM et al (2014) Frailty measurements and dysphagia in the outpatient setting. Ann Otol Rhinol Laryngol. 2014;123:629-35
15. Hathaway B, Baumann B, Byers S et al (2015) Handgrip strength and dysphagia assessment following cardiac surgery. Laryngoscope.2015;125:2330-2.
16. Madhavan A, LaGorio LA, Crary MA et al (2016) Prevalence of and Risk Factors for Dysphagia in the Community Dwelling Elderly: A Systematic Review. J Nutr Health Aging. 2016;20:806-15.
17. Melgaard D, Baandrup U, Bøgsted M et al (2017) The Prevalence of Oropharyngeal Dysphagia in Danish Patients Hospitalised with Community-Acquired Pneumonia. Dysphagia. 2017;32:383-92.
18. Belafsky PC, Mouadeb DA, Rees CJ et al (2008) Validity and reliability of the Eating Assessment Tool (EAT-10). Ann Otol Rhinol Laryngol.2008;117:919-24.
19. Cheney DM, Siddiqui MT, Litts JK et al (2015) The ability of the 10-item eating assessment tool (EAT-10) to predict aspiration risk in persons with dysphagia. Ann Otol Rhinol Laryngol. 2015;124:351-54.
20. Bahat G, Tufan A, Tufan F et al (2016) Cut-off points to identify sarcopenia according to European Working Group on Sarcopenia in Older People (EWGSOP) definition. Am J Clin Nutr. 2016;35:1557-63.
21. van Kan GA, Rolland Y, Andrieu S, et al (2009) Gait speed at usual pace as a predictor of adverse outcomes in community-dwelling older people an International Academy on Nutrition and Aging (IANA) Task Force. J Nutr Health Aging.2009;13:881-9.
22. Cho CY, Alessi CA, Cho M et al. (1998)The association between chronic illness and functional change among participants in Comprehensive Geriatric Assessment Program. J Am Geriatr Soc. 1998;46:677–82.
23. Butler SG, Stuart A, Leng X et al (2011) The relationship of aspiration status with tongue and handgrip strength in healthy older adults. J Gerontol A Biol Sci Med Sci. 2011;66:452-8.

24. Buehring B, Hind J, Fidler E et al (2013) Tongue strength is associated with jumping mechanography performance and handgrip strength but not with classic functional tests in older adults. J Am Geriatr Soc. 2013;61:418-22.
25. Rofes L, Arreola V, Romea M et al (2010) Pathophysiology of oropharyngeal dysphagia in the frail elderly. Neurogastroenterol Motil. 8:851-8.
26. van der Maarel-Wierink CD, Vanobbergen J2010;N, Bronkhorst EM et al (2011) Meta-analysis of dysphagia and aspiration pneumonia in frail elders. J Dent Res. 2011;12:1398–404.