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Presbyphagia

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<http://dx.doi.org/10.5772/60780>

1. Introduction

Everybody is eager to attain old age while preserving as much of their capabilities as possible. The lifespan has indeed increased considerably but is this also true for the disease-free period? Dealing with geriatric patients, there is growing awareness of the importance of the link between old age and swallowing problems. Although the severity and the nature of the swallowing problems are variable, deglutition in the elderly is somewhat compromised due to a decreased functional reserve [1]. However, it is important to distinguish between changes due to normal aging (i.e., presbyphagia) and changes due to pathologic conditions (i.e., dysphagia) caused by age-related diseases and their treatment. In primary aging a number of functions stay preserved, a number of functions deteriorate, and some compensatory mechanisms are evident.

Though a number of physiological, anatomical, and functional changes take place in the process of aging inducing an increased risk for dysphagia in older patients, the swallowing of a healthy older adult is not per se impaired. *Presbyphagia* refers to characteristic changes in the swallowing mechanism of otherwise healthy older adults [2].

While presbyphagia remains largely asymptomatic, as in contrast to presbyopia or presbycusis [3], dysphagia implies the presence of a symptomatic swallowing problem. In healthy aging there seems to be no reduction of the quality of life linked to deglutition [4]. Dysphagia arises from the combination of presbyphagia and a pathologic condition such as a stroke [5], Parkinson's disease [6], or dementia [7], just to mention the three most frequently encountered ones. Moreover, the geriatric patient with a diminished functional reserve, admitted in hospital with an acute illness, may develop a delirious state and subsequently a swallowing problem. There is also an increased likelihood that iatrogenic causes such as medication, surgical interventions, or radiotherapy are involved and finally the so-called frail elderly may be

reaching the lower limits of his physiological reserves, which may induce a swallowing problem.

2. Changes due to normal aging

Swallowing is an integrated neuromuscular process in which volitional and relatively automatic movements successively are controlled. Normal swallowing consists of 5 phases: an anticipating phase, an oral preparatory phase, an oral phase, a pharyngeal phase, and finally an esophageal phase [2].

The act of swallowing starts with the anticipation when seeing and smelling the food and in a cognitively adequate elderly person with normal eyesight there are no changes whatsoever in this first phase.

In the second phase or *oral preparatory phase*, the solid bolus needs preparation to be swallowed. Of course the dentures play an important role here; elderly who are often lacking teeth or who are wearing ill-fitted dentures may experience problems in chewing and as a consequence they may have made some spontaneous adaptations as far as their diet is concerned, and they are, for example, likely to avoid raw vegetables and certain meats. It has also been established that with ill-fitted dentures the masticating muscles function less well, thereby leading to a prolongation of the chewing process and to a larger number of chewing movements [8, 9]. The saliva production, a factor strongly related to subjective comfort during swallowing, on the other hand, will remain intact with aging, with xerostomia in old age being mostly due to medication [10].

2.1. Oral phase

This phase comprises the manipulation and transportation of the food in the mouth; the tongue propels the food in one fluid movement into the pharynx. When reaching the “trigger zone” near the faucial pillars, the reflexively pharyngeal phase will be initiated. Labial, buccal, and lingual actions, in combination with saliva, all work together to manipulate the food and to ultimately mechanically formulate a bolus. This bolus is then moved to the posterior side of the mouth into the inlet of the superior aspect of the pharynx. With aging the tongue strength declines, yet during swallowing itself the tongue strength is similar as in young people probably indicating a compensation for a diminished functional reserve [11]. The duration of the oral phase increases while there is also an increase of residue in the mouth post swallowing [12]. Here, it is important to have a good evacuation of the bolus because food that rests lingering in the oral cavity may lead to bacterial overgrowth and to aspiration as well.

2.2. Pharyngeal phase

The oral cavity and pharynx contains an enormous amount of sensory receptors, represented by dense intricate nerve supply to the oral cavity, pharynx, and larynx. The exact timing of the onset of the pharyngeal swallow is triggered by reflexes based on the input from these sensory

receptors in such a way that even a one-second delay in initiation can result in airway invasion of ingested material or aspiration.

This phase starts with the initiation of the swallowing reflex, and the triggering of this reflex is somewhat delayed in the elderly [13], which again points to a reduced functional reserve although there is still sufficient time to close the airway.

In the elderly, there is an increased distance between the hyoid bone and the larynx [14, 15]. This leads in combination with sarcopenia to a larger pharyngeal space that needs clearing at deglutition [14]. The hyoidal movement in the superior and anterior direction plays a crucial role as it is important not only for safety reasons as it moves the entrance of the airway further away from the bolus but also for reasons of efficiency as this movement is responsible for the opening of the upper esophageal sphincter (UES). This movement declines with aging and is even in healthy elderly already significantly reduced compared with younger individuals.

The safety of swallowing is further bolstered by the movement of the epiglottis and by active approximation of the vocal cords and both mechanisms remain intact [16, 17].

The opening of the UES, as observed on videofluoroscopy, is unchanged but in approximately 30% of the healthy elderly one can observe the presence of a so-called cricopharyngeal bar, a posterior impression at the pharyngoesophageal segment [15]. The cricopharyngeal bar is a frequent incidental radiologic finding, which in many cases does not cause any symptoms.

When the UES is investigated in the elderly with manometry, it shows a decreased relaxation of the UES often in combination with increased amplitude of the pharyngeal contraction [2, 18-22]. The intrabolus pressure measured at the level of the UES is also elevated. And to be complete in the description of this phase we see that at the top of the pharynx the velopharyngeal closure remains intact.

Due to these physiological changes normal in aging, the pharyngeal transit time is significantly increased in old age [2].

Swallow safety and swallow efficiency not only imply an adequate motor function but also a preserved sensibility. Increasing age is often associated with a declined perception of spatial tactile recognition on the lip and tongue [23] and the rest of the oral cavity.

A study that used air pulses at the posterior pharyngeal wall at the level of the piriform sinuses showed a decreased sensibility in old age and as a consequence the amount of pharyngeal residue required to initiate a so-called clearing swallow proved to be significantly higher than in young persons [24-26].

In older healthy adults, it is not uncommon for the bolus to spend a greater length of time next to an open airway, by pooling in the piriform sinuses and in the valleculae, than in younger adults. This senescent change may be associated with greater risk for airway penetration or aspiration.

Swallow safety means that no material enters the airway; one distinguishes between penetration and aspiration. While in penetration nothing descends beyond the level of the true vocal

cords, one speaks of aspiration when this is indeed the case with material ending up in the tracheal structures. In healthy elderly, there seems to be an increased incidence of penetration but not of aspiration [2, 27]. Another important clinical parameter consists of swallow efficiency, that is, the possibility to transport a bolus through the pharynx without leaving residue. Several studies have shown that residue both at the vallecular and the piriform sinuses level is frequently encountered in healthy asymptomatic elderly [22, 28]. With a new technique (Automated Impedance Manometry or AIM), it is possible to measure a Swallow Risk Index (SRI) [22]. This index is based on a number of manometric and impedance parameters and is clearly higher in the elderly pointing at an elevated level of swallowing dysfunction.

2.3. The esophageal phase

In 1974, it was shown that in elderly men above 80 years of age without comorbidities the peristaltic amplitude was significantly lower than in younger controls, but without changes in the speed or duration of the peristaltic wave [29]. The authors stated that aging results in a weaker esophageal muscle but with intact innervation. Later on the technique to perform manometric studies was further improved facilitating the discovery that the duration of the peristaltic wave increases in the aged population [30, 31].

Another manometric study of healthy Japanese volunteers showed that the elderly population (>60 years) had decreased peristaltic contraction amplitude compared to the young control group (<49 years) [32]. But in a similarly large study comparing older (>65 years) and younger (<45 years) patients with dysphagia, they could not find any significant difference in peristaltic amplitude, duration, and LES (lower esophageal sphincter) pressure [33].

Finally several studies have indicated an increase in both the amount of failed peristaltic events as well as in synchronous contractions [34].

To summarize, most studies in healthy elderly indicated that approximately 90% of these subjects had impaired peristaltic activity, while no peristalsis at all was observed in one third of them. Moreover the incidence of non-peristaltic contractions of the esophagus increases with age.

In conclusion, it is not easy to compare the preceding studies due to differences in subject population, average ages, and degree of comorbidities as well as differences in manometric and radiographic techniques. It appears that in subjects older than 90, the majority have comorbidities that would possibly predispose them to an esophageal motility disorder making it difficult to distinguish whether dysmotility in this group is due to age and disease or disease alone. In subjects aged 60 to 80, the duration of peristalsis is prolonged and the amplitude may be lessened, although whether these findings are clinically significant remains unclear. In healthy subjects aged from 80 to 90, esophageal muscle weakness exists but the swallow function remains intact. Although certain parameters change significantly with aging, the swallow safety and swallow efficiency are still adequately preserved in normal aging.

A summary of the changes can be found in Table 1.

ORAL PREPARATORY PHASE	
Altered function	Loss of teeth Chewing problems [9]
No change	Saliva production [10]
Compensatory functions	Increased duration [8] Increased number of chewing movements [9]
ORAL PHASE	
Altered functions	Decreased functional reserve of the tongue strength [11] Increased oral residue [12]
No changes	Tongue strength during swallowing [11]
PHARYNGEAL PHASE	
Altered functions	<i>At the motor level</i>
	Decreased movement of the hyoid [16]
	Decreased pharyngeal constriction [15]
	Decreased relaxation of the UES [18-21]
	Reduced opening of the UES [22]
	Increased duration [2, 15]
	<i>At the sensory level</i>
	Delayed swallow reflex [1, 9, 13, 16]
No changes	Decreased sensibility of the posterior pharyngeal wall [24, 25]
	Downward movement of the epiglottis [16]
	Active closure of the vocal cords [17]
	Velopharyngeal closure [2]
Compensatory function	Increased pharyngeal contractility [18, 19]
Deglutition in general	
Altered functions	Increased incidence of penetration [18,26]
	increased pharyngeal residue [22, 28]
No change	No aspiration [2, 27]

3. Changes associated with normal aging, which might influence swallowing

A holistic approach is required while studying swallowing in the elderly. Swallowing cannot be regarded as an isolated action; one has to take into account the age-related functional decline occurring in several body-functions and its repercussions on swallowing (figure 1).

First of all there is an age-related decrease of sense of smell and taste, which are important for the pleasure we enjoy while eating [35-37].

Also, some anatomical differences arise in the older person such as a smaller cross-sectional area of masticatory muscles (masseter and medial pterygoid) and an increased lingual atrophy [38]. Next to the anatomical changes also, functional alterations occur in the muscle activity of the masseter, orbicularis oris, the supra- and infra-hyoid muscles [39], and the thyroarytenoid muscle [39].

The respiratory system undergoes some changes as well; there is a decreased cough reflex, a diminished ciliary clearing, and a weakening of the respiratory muscles. These changes in combination with a deterioration of the immune system make the elderly more prone to developing an aspiration pneumonia.

As far as the digestive system is concerned, a delayed gastric emptying may lead to an earlier feeling of fullness at mealtime. Recent studies have shown a decreased sensibility and an increased stiffness of the esophagus in old age [40].

Another important issue is fatigue [41]. Fatigue, being a very common complaint in the elderly, is often associated with functional decline and may, as well as sleeping disturbances and depression, lead to a reduced food intake [42-44]. The elderly also often experience a declined perception of thirst and subsequently they have a low fluid intake. Tongue strength and endurance decline during a meal and this in combination with a diminished reserve may negatively influence deglutition especially in already weakened elderly [45].

As people get older, the slower swallowing act may actually also be a benefit as it can allow greater time to recruit the necessary number of muscle fibers to generate the necessary pressures for adequate bolus propulsion through the oropharynx. Hence, speeding up an elderly patient's swallow may induce contradictory results, as it may lead to insufficient swallow pressures and therefore may be contraindicated as a therapy technique.

Cognitive changes are also considered to be part of the normal aging process and cognitive processes such as concentration, attention, and double-tasking are influenced by age. A decline in concentration and attention together with a reduced reserve may lead to aspiration. Moreover as eating is a social event, people tend to talk during mealtime further increasing the risk of penetration and aspiration.

Staying physically active is associated with healthy aging, therefore elderly who are bedridden are additionally exposed to a number of important risk factors due to the sedative life style such as a diminished lung capacity and a weaker cough, a greater risk to develop a pneumonia, muscle weakness, and a loss of appetite [46].

Finally, medication may also negatively influence deglutition [47]. Drugs with an anticholinergic effect may cause xerostomia while some may lead to a diminished (e.g., allopurinol, carbamazepine, and penicillamine) or an altered (e.g., captopril lithium) taste perception. Sedatives can reduce the level of alertness and neuroleptics may mimic the swallowing problems encountered in Parkinson's disease. Nitrates are relatively contraindicated in gastro-esophageal, reflux disease as they lower the pressure in the lower gastro-esophageal sphincter and steroids can not only induce a Candida infection orally but they can also provoke a steroid myopathy. Moreover, 40% of already weakened elderly take at least one medication that is completely superfluous [48].

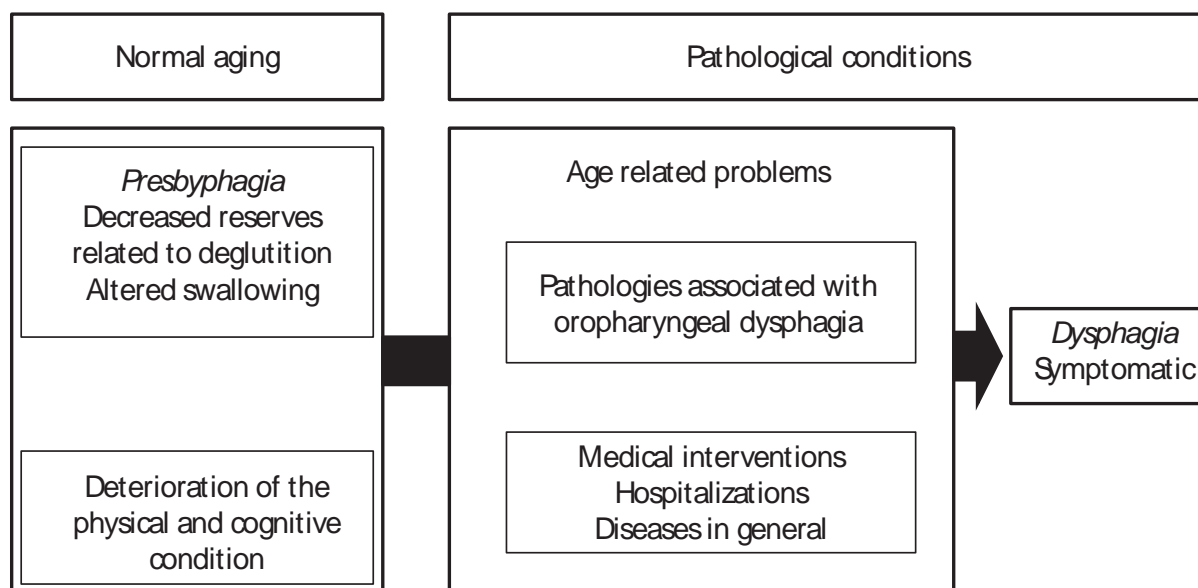


Figure 1. The relationship between presbyphagia and dysphagia

4. Implications for the clinical practice: prevention and detection of swallowing problems

a. Detection

In view of the high prevalence of dysphagia in the elderly and its important consequences such as malnutrition, dehydration, aspiration pneumonia, acute food impaction, and a reduced quality of life, it is crucial to detect swallowing problems at an early stage. Moreover, the elderly themselves are not always aware of their deglutition problems [49]. In a study on 47 elderly women living at home a questionnaire was used to assess swallowing problems. Participants were all observed while drinking water. Only 44% of those in whom a clinical problem was observed admitted having experienced a deglutition problem [50]. The personnel in nursing homes is often not well trained to detect these problems [51], while for isolated elderly living at home this can be a challenge for their GP. When an elderly is admitted to a geriatric ward, the geriatrician as well as the nursing staff plays a key role in detecting a swallow problem.

In Table 2 some tips are given as to when presbyphagia is suspected and when there might be a pathologic condition.

b. Prevention

As prevention is always preferred over cure, an overview is here presented with the most common preventative measures to allow a safe oral intake in the elderly.

Symptoms indicating the presence of presbyphagia	Symptoms indicating the presence of dysphagia
Prolonged chewing in a person with no teeth or ill-fitted dentures	Significantly prolonged duration of a meal
Diminished taste	No taste
Less appetite	Important lack of appetite
The elder drinks less	Drinking fluids has become so difficult that he avoids it
The elder chokes seldom when his attention decreases (e.g., when talking during mealtime)	He often chokes at mealtime, coughs frequently, and/or develops a wet voice during or after a meal
In general there are no problems with eating, only hard consistencies might be a challenge	He avoids several foods and the difficulties at swallowing may influence his quality of life
He chokes seldom on his own saliva	He is continuously coughing and has a wet voice

Advices

Pay attention to a good hygiene of the mouth

Clean your dentures adequately, make them fit well

Discard any food residue from your mouth after mealtime

Keep your mouth moist by rinsing or drinking at regular intervals

Pay attention to eat and drink moments

Avoid eating and drinking when you are extremely tired or when your concentration is diminished.

Do not speak during mealtime but start a conversation afterward.

Do not eat just prior going to sleep.

Remain in an upright position at least 5 to 10 min following a meal.

Adaptations of food

When experiencing difficulties chewing raw vegetables or some meat, you may cut it in very small pieces.

When your food tastes insufficiently, you may add some spices.

When you aspirate now and then on fluids, chilling it and adding some flavor could be a good idea.

When you aspirate now and then on your own saliva try to think to swallow it on a regular base for instance whenever you look for the time thereby making it a habit.

Medication

Take your pills only when you are perfectly alert and sitting upright.

Remain in a prone position, at least 5 to 10 minutes.

Drink sufficient water during and after the medication.

When swallowing medication proves difficult mention it to your physician so that he can look for an alternative route of administration (sublingual, transdermal).

General advice

Stay active

When to consult a physician in case of deglutition problems?

When you are worried

When you choke regularly

When you cough regularly during and between meals

When you eat a lot slower

When you stop enjoying to eat and drink

When you lose weight

5. Conclusions

Swallow safety is preserved in normal aging. Yet there are a number of changes, which bring the elderly in a more vulnerable position. Moreover, the elderly are more frequently confronted with events likely to provoke a deglutition problem.

All medical personnel dealing with the elderly should be alert not to miss any sign that might suggest the presence of a swallowing problem. Finally, the elderly should receive proper advice on how to cope with changes due to normal aging.

Acknowledgements

We hereby acknowledge that the tables in this manuscript are based on the following article: Presbyfagie: de invloed van het primair verouderingsproces op de slikfunctie. Liesenborghs C, Dejaeger E, Liesenborghs L, Tack J, Rommel N. *Tijdschr Gerontol Geriatr* 2014; 45: 261-272.

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References

- [1] Logemann J. *Slikstoornissen: Onderzoek en Behandeling* Amsterdam: Harcourt. 2000.
- [2] Robbins J, Hamilton JW, Lof GL, Kempster GB. Oropharyngeal swallowing in normal adults of different ages. *Gastroenterology*. 1992 Sep;103(3):823-9. PubMed PMID: 1499933.
- [3] Van Den Noortgate N. *Lichamelijke veranderingen en de gevolgen van veroudering*. Lannoo Leuven. 2006.

- [4] Cassol K, Galli JF, Zamberlan NE, Dassie-Leite AP. Quality of life in swallowing in healthy elderly. *Jornal da Sociedade Brasileira de Fonoaudiologia*. 2012;24(3):223-32. PubMed PMID: 23128170.
- [5] Truelsen T, Piechowski-Jozwiak B, Bonita R, Mathers C, Bogousslavsky J, Boysen G. Stroke incidence and prevalence in Europe: a review of available data. *European journal of neurology : the official journal of the European Federation of Neurological Societies*. 2006 Jun;13(6):581-98. PubMed PMID: 16796582.
- [6] Willis AW. Parkinson disease in the elderly adult. *Missouri medicine*. 2013 Sep-Oct; 110(5):406-10. PubMed PMID: 24279192.
- [7] Berr C, Wancata J, Ritchie K. Prevalence of dementia in the elderly in Europe. *European neuropsychopharmacology : the journal of the European College of Neuropsychopharmacology*. 2005 Aug;15(4):463-71. PubMed PMID: 15955676.
- [8] Chichero J MB. *Dysphagia Foundation, theory and practice*. Chichester: John Wiley & Sons Ltd 2006.
- [9] Mioche L, Bourdiol P, Monier S, Martin JF, Cormier D. Changes in jaw muscles activity with age: effects on food bolus properties. *Physiology & behavior*. 2004 Sep 30;82(4):621-7. PubMed PMID: 15327909.
- [10] Ship JA, Pillemer SR, Baum BJ. Xerostomia and the geriatric patient. *Journal of the American Geriatrics Society*. 2002 Mar;50(3):535-43. PubMed PMID: 11943053.
- [11] Todd JT, Lintzenich CR, Butler SG. Isometric and swallowing tongue strength in healthy adults. *The Laryngoscope*. 2013 Oct;123(10):2469-73. PubMed PMID: 23918664.
- [12] Logemann JA, Pauloski BR, Rademaker AW, Kahrilas PJ. Oropharyngeal swallow in younger and older women: videofluoroscopic analysis. *Journal of speech, language, and hearing research : JSLHR*. 2002 Jun;45(3):434-45. PubMed PMID: 12068997.
- [13] Leonard R, McKenzie S. Hyoid-bolus transit latencies in normal swallow. *Dysphagia*. 2006 Jul;21(3):183-90. PubMed PMID: 16897323.
- [14] Leonard RJ SR. *Effect of aging on the pharynx and the UES Principles of Deglutition: A Multidisciplinary Text for Swallowing and its Disorders*. New York: Springer. 2013..
- [15] Leonard R, Kendall K, McKenzie S. UES opening and cricopharyngeal bar in nondysphagic elderly and nonelderly adults. *Dysphagia*. 2004 Summer;19(3):182-91. PubMed PMID: 15383948.
- [16] Logemann JA, Pauloski BR, Rademaker AW, Colangelo LA, Kahrilas PJ, Smith CH. Temporal and biomechanical characteristics of oropharyngeal swallow in younger and older men. *Journal of speech, language, and hearing research : JSLHR*. 2000 Oct; 43(5):1264-74. PubMed PMID: 11063246.

- [17] Shaker R, Ren J, Bardan E, Easterling C, Dua K, Xie P, et al. Pharyngoglottal closure reflex: characterization in healthy young, elderly and dysphagic patients with predeglutitive aspiration. *Gerontology*. 2003 Jan-Feb;49(1):12-20. PubMed PMID: 12457045.
- [18] Shaker R, Ren J, Podvrsan B, Dodds WJ, Hogan WJ, Kern M, et al. Effect of aging and bolus variables on pharyngeal and upper esophageal sphincter motor function. *The American journal of physiology*. 1993 Mar;264(3 Pt 1):G427-32. PubMed PMID: 8460698.
- [19] van Herwaarden MA, Katz PO, Gideon RM, Barrett J, Castell JA, Achem S, et al. Are manometric parameters of the upper esophageal sphincter and pharynx affected by age and gender? *Dysphagia*. 2003 Summer;18(3):211-7. PubMed PMID: 14506987.
- [20] Shaw DW, Cook IJ, Gabb M, Holloway RH, Simula ME, Panagopoulos V, et al. Influence of normal aging on oral-pharyngeal and upper esophageal sphincter function during swallowing. *The American journal of physiology*. 1995 Mar;268(3 Pt 1):G389-96. PubMed PMID: 7900799.
- [21] Kern M, Bardan E, Arndorfer R, Hofmann C, Ren J, Shaker R. Comparison of upper esophageal sphincter opening in healthy asymptomatic young and elderly volunteers. *The Annals of otology, rhinology, and laryngology*. 1999 Oct;108(10):982-9. PubMed PMID: 10526854.
- [22] Omari TI, Kritas S, Cock C, Besanko L, Burgstad C, Thompson A, et al. Swallowing dysfunction in healthy older people using pharyngeal pressure-flow analysis. *Neurogastroenterology and motility : the official journal of the European Gastrointestinal Motility Society*. 2014 Jan;26(1):59-68. PubMed PMID: 24011430.
- [23] Wohlert AB. Tactile perception of spatial stimuli on the lip surface by young and older adults. *Journal of speech and hearing research*. 1996 Dec;39(6):1191-8. PubMed PMID: 8959604.
- [24] Aviv JE, Martin JH, Jones ME, Wee TA, Diamond B, Keen MS, et al. Age-related changes in pharyngeal and supraglottic sensation. *The Annals of otology, rhinology, and laryngology*. 1994 Oct;103(10):749-52. PubMed PMID: 7944164.
- [25] Aviv JE. Effects of aging on sensitivity of the pharyngeal and supraglottic areas. *The American journal of medicine*. 1997 Nov 24;103(5A):74S-6S. PubMed PMID: 9422628.
- [26] Shaker R, Ren J, Zamir Z, Sarna A, Liu J, Sui Z. Effect of aging, position, and temperature on the threshold volume triggering pharyngeal swallows. *Gastroenterology*. 1994 Aug;107(2):396-402. PubMed PMID: 8039616.
- [27] Almirall J, Rofes L, Serra-Prat M, Icart R, Palomera E, Arreola V, et al. Oropharyngeal dysphagia is a risk factor for community-acquired pneumonia in the elderly. *The European respiratory journal*. 2013 Apr;41(4):923-8. PubMed PMID: 22835620.
- [28] Dejaeger E, Pelemans W, Bibau G, Ponette E. Manofluorographic analysis of swallowing in the elderly. *Dysphagia*. 1994 Summer;9(3):156-61. PubMed PMID: 8082323.

- [29] Hollis JB, Castell DO. Esophageal function in elderly man. A new look at "presbyesophagus". *Annals of internal medicine*. 1974 Mar;80(3):371-4. PubMed PMID: 4816179.
- [30] Ren J, Shaker R, Kusano M, Podvrsan B, Metwally N, Dua KS, et al. Effect of aging on the secondary esophageal peristalsis: presbyesophagus revisited. *The American journal of physiology*. 1995 May;268(5 Pt 1):G772-9. PubMed PMID: 7762661.
- [31] Aly YA, Abdel-Aty H. Normal oesophageal transit time on digital radiography. *Clinical radiology*. 1999 Aug;54(8):545-9. PubMed PMID: 10484223.
- [32] Nishimura N, Hongo M, Yamada M, Kawakami H, Ueno M, Okuno Y, et al. Effect of aging on the esophageal motor functions. *Journal of smooth muscle research = Nihon Heikatsukin Gakkai kikanshi*. 1996 Apr;32(2):43-50. PubMed PMID: 8845565.
- [33] Robson KM, Glick ME. Dysphagia and advancing age: are manometric abnormalities more common in older patients? *Digestive diseases and sciences*. 2003 Sep;48(9):1709-12. PubMed PMID: 14560988.
- [34] Grande L, Lacima G, Ros E, Pera M, Ascaso C, Visa J, et al. Deterioration of esophageal motility with age: a manometric study of 79 healthy subjects. *The American journal of gastroenterology*. 1999 Jul;94(7):1795-801. PubMed PMID: 10406237.
- [35] Doty RL, Kamath V. The influences of age on olfaction: a review. *Frontiers in psychology*. 2014;5:20. PubMed PMID: 24570664. Pubmed Central PMCID: 3916729.
- [36] Baruch P. D-PL, Feenstra R., Roos R., Sterk C., Zintuigen en communicatie uit: Inleiding gerontologie en geriatrie. Houten: Bohn Stafleu von Loghum. 2004.
- [37] Methven L, Allen VJ, Withers CA, Gosney MA. Ageing and taste. *The Proceedings of the Nutrition Society*. 2012 Nov;71(4):556-65. PubMed PMID: 22883349.
- [38] Nakayama M. [Histological study on aging changes in the human tongue]. *Nihon Jibiinkoka Gakkai kaiho*. 1991 Apr;94(4):541-55. PubMed PMID: 2061734.
- [39] Takeda N, Thomas GR, Ludlow CL. Aging effects on motor units in the human thyroarytenoid muscle. *The Laryngoscope*. 2000 Jun;110(6):1018-25. PubMed PMID: 10852524.
- [40] Menard-Katcher P. FG. Normal aging and the esophagus from: *Principles of Deglutition: A multidisciplinary text for swallowing and its disorders.* New York: Springer. 2013.
- [41] Poluri A, Mores J, Cook DB, Findley TW, Cristian A. Fatigue in the elderly population. *Physical medicine and rehabilitation clinics of North America*. 2005 Feb;16(1):91-108. PubMed PMID: 15561546.
- [42] Forlani C, Morri M, Ferrari B, Dalmonte E, Menchetti M, De Ronchi D, et al. Prevalence and gender differences in late-life depression: a population-based study. *The American journal of geriatric psychiatry : official journal of the American Association for Geriatric Psychiatry*. 2014 Apr;22(4):370-80. PubMed PMID: 23567427.

- [43] Phillips PA, Rolls BJ, Ledingham JG, Forsling ML, Morton JJ, Crowe MJ, et al. Reduced thirst after water deprivation in healthy elderly men. *The New England journal of medicine*. 1984 Sep 20;311(12):753-9. PubMed PMID: 6472364.
- [44] Brownie S. Why are elderly individuals at risk of nutritional deficiency? *International journal of nursing practice*. 2006 Apr;12(2):110-8. PubMed PMID: 16529597.
- [45] Kays SA, Hind JA, Gangnon RE, Robbins J. Effects of dining on tongue endurance and swallowing-related outcomes. *Journal of speech, language, and hearing research : JSLHR*. 2010 Aug;53(4):898-907. PubMed PMID: 20689047. Pubmed Central PMCID: 3077124.
- [46] Rousseau P. Immobility in the aged. *Archives of family medicine*. 1993 Feb;2(2):169-77; discussion 78. PubMed PMID: 8275186.
- [47] Dejaeger E. Slikstoornissen. Leuven: Acco. 2007.
- [48] Hajar ER, Hanlon JT, Sloane RJ, Lindblad CI, Pieper CF, Ruby CM, et al. Unnecessary drug use in frail older people at hospital discharge. *Journal of the American Geriatrics Society*. 2005 Sep;53(9):1518-23. PubMed PMID: 16137281.
- [49] Gonzalez-Fernandez M, Humbert I, Winegrad H, Cappola AR, Fried LP. Dysphagia in old-old women: prevalence as determined according to self-report and the 3-ounce water swallowing test. *Journal of the American Geriatrics Society*. 2014 Apr;62(4):716-20. PubMed PMID: 24635053.
- [50] DePippo KL, Holas MA, Reding MJ. Validation of the 3-oz water swallow test for aspiration following stroke. *Archives of neurology*. 1992 Dec;49(12):1259-61. PubMed PMID: 1449405.
- [51] Pelletier CA. What do certified nurse assistants actually know about dysphagia and feeding nursing home residents? *American journal of speech-language pathology / American Speech-Language-Hearing Association*. 2004 May;13(2):99-113. PubMed PMID: 15198630.

