Tikrit Journal of Pharmaceutical Sciences 2022; 16(1):66-90
http://doi.org/10.25130/tjphs.2022.16.1.8.66.90

IRAQI Academic Scientific Journals

Tikrit Journal of Pharmaceutical Sciences

Available online at: https://tjphs.tu.edu.iq

ISSN: 1815-2716(print); ISSN: 2664-231X (online)

T. J. Ph. S.

Physiological Alterations in Swallowing in Elderly People: A Systematic Review

***Hiba Hazim Saleh**

Department of Pharmacology and Toxicology, College of Pharmacy, Tikrit university

ARTICLE INFO.

Article history:

-Received: 26/9/2022
-Accepted: 16/10/2022
-Available online: 16/12/2022

Keywords:

Swallowing – physiological alterations - Deglutition - Systematic review – Elderly Healthy volunteers

***Corresponding author:**

Hiba Hazim Saleh
: Email
Hiba.hazim@tu.edu.iq

Contact To Journal

E-mail: tjops@tu.edu.iq

Citation:
Saleh HH. Physiological Alterations in Swallowing in Elderly People: A Systematic Review. Tikrit Journal of Pharmaceutical Sciences 2022; /16(1):66-90. http://doi.org/10.25130.tjphs.2022.16.1.8 66.90

Abstract

Many changes in swallowing function occur in the elderly, age-related swallowing alterations are well-researched and frequently identify people above sixty as older people. The effect of age on swallowing should be clarified to improve. Understanding the impact of age on swallowing has implications for differentiating between swallowing difficulties associated with ageing and those associated with specific medical conditions. Older folks are living longer and in better health than ever before, with many living past 85 years of age. To effectively address swallowing issues in elderly patients, doctors must comprehend healthy swallowing modifications in the "oldest old". This systematic review compiled and evaluated papers that used instrumental evaluation to look at alterations in swallowing in persons over 85. Participants over 85 who were in good health were required for participation. Studies that focused on oral functioning and anatomy were prohibited .Two thousand two hundred thirty-six (2236) papers from investigations up to 2018 were gathered from Scopus, Embase, CINAHL, Medline, and BIOSIS. Because the oldest old were not enrolled, 86% of investigations examining age-related swallowing alterations were disregarded after data screening. Thirteen articles passed the PRISMA assessment and were considered. These were then examined for quality, bias, and data extractions. The primary quantitative abnormalities in swallowing associated with ageing were an increase in the swallow onset delays, bolus transit times. Identify of the 'normal' for swallowing in elderly is important to clinical and instrumental swallow examinations and to inform interventions that might effect on the person's life. Fewer papers found elevated residue or aspiration-related airway impairment. Due to differences in age groups, criteria for classifying individuals as "healthy," measurements employed to define swallowing physiology, and swallowing activities, findings could not be easily compared. There are identified swallowing alterations that are caused by ageing but do not endanger safety. Normative deglutition study underrepresents the oldest old. It is crucial that future research consider recruiting people above 85 years old.

التعديلات الفسيولوجية في البلع عند كبار السن: مراجعة منهجية

الملخص :

تحدث العديد من التغييرات في وظيفة البلع عند كبار السن ، كما أن تغييرات البلع المرتبطة بالعمر مدروسة جيدًا ، وكثيرًا ما تحدد الأشخاص فوق الستين من كبار السن. يجب توضيح تأثير العمر على البلع لتحسينه. إن فهم تأثير العمر على البلع له آثار على التمييز بين صعوبات البلع المرتبطة بالشيخوخة وتلك المرتبطة بحالات طبية معينة. يعيش الأشخاص الأكبر سنًا لفترة أطول وبصحة أفضل من أي وقت مضى ، حيث يعيش العديد منهم بعد ٨٥ عامًا. لمعالجة مشاكل البلع بشكل فعال عند المرضى المسنين ، يجب على الأطباء فهم تعديلات البلع الصحية في "الأكبر سنًا". جمعت هذه المراجعة المنهجية وقيمت الأوراق التي استخدمت التقييم الفعال للنظر في التغيرات في البلع لدى الأشخاص فوق ٨٥ عامًا. كان المشاركون الذين تزيد أعمارهم عن ٨٥ عامًا والذين كانوا بصحة جيدة مطلوبين للمشاركة. تم حظر الدراسات التي ركزت على وظائف الفم والتشريح. تم جمع ألفين ومائتين وستة وثلاثين (٢٢٣٦) ورقة من التحقيقات حتى عام ٢٠١٨ من Scopus و Embase و CINAHL و Medline و BIOSIS. نظرًا لعدم تسجيل الأكبر سناً ، تم تجاهل ٨٦٪ من التحقيقات التي تفحص تغييرات البلع المرتبطة بالعمر بعد فحص البيانات. مرت ثلاثة عشر مقالاً بتقييم PRISMA وتم النظر فيها. ثم تم فحصها من أجل الجودة والتحيز واستخراج البيانات. كانت الشذوذات الكمية الأولية في البلع المرتبطة بالشيخوخة زيادة في تأخير بدء البلع ، وأوقات عبور البلعة. تحديد "الطبيعي" للبلع عند كبار السن أمر مهم للفحوصات السريرية والفعالة للبلع ولإبلاغ التدخلات التي قد تؤثر على حياة الشخص. وجدت أوراق أقل بقايا مرتفعة أو ضعف مجرى الهواء المرتبط بالشفط. بسبب الاختلافات في الفئات العمرية ، ومعايير تصنيف الأفراد على أنهم "أصحاء" ، والقياسات المستخدمة لتحديد فسيولوجيا البلع ، وأنشطة البلع ، لا يمكن مقارنة النتائج بسهولة. توجد تغييرات محددة في البلع ناتجة عن الشيخوخة ولكنها لا تعرض السلامة للخطر. دراسة الانحلال المعياري لا تمثل الأقدم. من الأهمية أن تنظر الأبحاث المستقبلية في تجنيد الأشخاص الذين تزيد أعمارهم عن ٨٥ عامًا.

Introduction :

Due to differences in age groups, criteria for classifying individuals as "healthy," measurements used to define swallows physiology, and swallowing activities, findings could not be easily compared. There are identified swallowing alterations that are caused by ageing but do not endanger security. Normative deglutition study underrepresents the oldest old. It is crucial that future research consider recruiting people above 85 years old [1, 2]. Aging is not the only factor in swallowing difficulties (dysphagia). Nevertheless, because of age-related illnesses, healthcare occurrences, multimorbidity, and pharmacological treatments, swallowing difficulty is more common as people get older [3]. Due to these, more elderly people are being referred for swallowing evaluations [4]. Aspiration pneumonia is one of the clinical repercussions of dysphagia [5, 6], malnutritions, as well as dehydrations [7], which could potentially be fatal. For older persons who have swallowing difficulties, the idealised image of retirements is different since it is not focused on social gatherings that include eating and drinking. A person's quality of life is adversely affected, burdening them as well as their partner, carers, family, and friends [8, 9].

To distinguish illness from normal variation and improve the managements of dysphagia, it is crucial to comprehend how healthy persons swallow across the lifespans [10]. Age-related swallowing evaluations and the deglutition literatures both do a good job of addressing how swallowing varies with ageing [11]. In the late 1980s [12, 13], studies on swallowing changes in healthy ageing initially surfaced. At this time, those who were sixty years of age or older were usually referred to as "elderly" in comparison to a younger age group. The following studies follow a similar format. The shift in population ageing raises questions about the focus of our follow-up research. Is it, for instance, preferable to study age-related variations using dichotomous age groups? But not for nations with rapidly ageing populations: a world event having health policy ramifications [12]. It seems improbable that the health and general capabilities of the 60- to 70-year-olds in these nations today are comparable to those of their contemporaries from the 1980s and 1990s. Furthermore, it does not seem proper to evaluate or contrast a retired adult with elderly people in their late 80s or early 90s. It will be challenging to assist folks who are living into senior age and reporting with swallowing difficulties without research that separate age groups across the lifetime [13, 14]. We performed a systematic review to compile and critically evaluate papers that used instrumental evaluation to look at swallowing alterations in healthier persons over the age of 85. Using the PICO model [15], what physiological alterations in swallowing are typical for the oldest old, as determined by experimental assessments, was our research question. Our hypothesis was that older persons' swallowing alterations are quantifiable and differed significantly from those seen in younger adults.

Methods :

This study's presentation adhered to the Standards for Systematic Reviews and Meta-Analyses (PRISMA).

Search Strategy :

Up till 2018, publications from Scopus, Medline, Embase, CINAHL, and BIOSIS were retrieved. We used the phrases "swallowing" and "normal" OR "typical" OR "healthy" in our generic search. Language, human studies, publication type (journal articles), and age (80 years and older) filters were applied to each database's findings (English). Medline was searched for MeSH terms like "deglutition" AND "healthy volunteers" OR "aged, 80 and over. "Duplicated search findings were eliminated and kept in Endnote (Clarivate Analytics, Philadelphia). A hand-search for further acceptable studies was conducted utilising the bibliographies of the publications that were accepted for review, first by screening titles and then abstracts. The full texts of studies that satisfied the requirements were critically reviewed before inclusion.

Study Analysis :

Following title and abstract filtering, publications were added to a spread sheet Microsoft Excel . Subsequently, using the PICO framework [16], data were gathered from pertinent research (Table1).

1. Respondents' age range, average age of oldest group, standard deviations, identities of patients, number of respondents (n), and criteria used to determine whether participants were considered "healthy".
2. Interventions: instrumental evaluation and swallowing exercises during the evaluation (bolus sizes and textures).
3. Comparators: the whole respondent count and the names of respondent groupings (n).
4. Results: displacements (cm), pressures (mmHg), swallowing durations (s), as well as occurrences of penetrations, aspirations, and residues.

Terms and definitions for time displace, and pressure of the bolus transit and swallowing were taken from researches. Age-related swallowing alterations that are significant and not significant were compiled. Measurements were taken, and differences between young and elderly were presented if there were any between-group discrepancies on any bolus categories. Each study assessed the proportion of people over 85 in accordance with the investigation topic.

Quality and Risk of Bias :

Utilizing a modified survey from the Critical Appraisal Skills Program, the whole transcripts of the listed publications were critically evaluated. The technique developed by the Cochrane Collaborations to evaluate bias risk has been modified to evaluate bias in efficacy, recognition, attrition, reporting, as well as other areas [16]. The GRADE method was employed to evaluate the quality of the evidence, considering bias risk, indirectness, inaccuracy, and reliability [17]. All data was reviewed during the phases of research selecting and quality assessment. Consensus was reached to overcome disagreements.

Results :

Ninety-six percent (300/313) of the 313 studies that looked into regular swallowing in older persons did not include the oldest aged. VFS (53.8%), VFS with LRM (15.4%), HRIM (23.1%), and LRM (7.6%) were used as instruments. (Table 1) shows the main description of the included investigations.

Duration of Bolus entrance into the Pharynx Contrary to When Swallows onset : Five investigations [VFS (4/5) and HRIM (1/5) evaluated the timing of bolus entrance into the pharynx to the commencement of swallowing using 2 distinct measurements (Table 2).

Comparing to bolus movements, 80% of the measurements (4/5) showed a substantial improvement in the delay of swallow initiation.

Bolus Transit Duration : For the most part of bolus transits measurements (11/15) indicated a significantly age-related increasing (Table 3). All studies (7/7) measured bolus transit using VFS.

Hyoid Measures : Age effects on hyoid displacements and timing have been studied using VFS, with different degrees of success (Table 4).

Airway Closure : In four trials, hyolaryngeal motion and time of airway closures utilising VFS were examined (Table 5).

Pharyngeal Constriction : Age-related variations in the pharyngeal contraction ratios, a fluoroscopic substitute for manometric pharyngeal pressure measurements [29] and manometric pharynx scheduling and pressures values, were observed in five studies (Table 6).

Upper Esophageal Sphincter (UES) Measures : Six studies—including one that used contemporaneous LRM—reported UES opening utilising VFS and HRIM. Six studies used VFS (containing two studies with contemporaneous LRM) and LRM to measure the length of the UES opening. In three trials, UES pressures measurements were computed using HRIM and LRM (Table 7).

Esophageal Measures : This systematic review comprised three investigations that examined the effects of ageing on the oesophagus utilising a variety of esophageal measurements, procedures, and analysis techniques (Table 8).

Observations : The majority of research that used VFS recorded if or not aspirations and penetrating were seen. Two investigations found no penetrating, and 4 researchers suggest no aspiration. 6/13 studies made comments. on pharyngeal residues. Pharyngeal residues (2/6) are three age-related consequences that have received little research (Tables 9, 10).

Bias Risk and Quality Evaluation Across Papers : No research showed a significant risk of bias, and all investigations overall had a minimal risk of reporting bias (Table 11). Investigations are first given a poor quality rating when using the GRADE system. No articles were downgraded because evaluations of uncertain bias risk were unlikely to significantly affect the outcomes of research. In all investigations, the procedures for experimental evaluations and the definitions of swallows measurements were covered in depth. References were included for study methods and/or data analysis in the majority of studies (12/13). Because swallowing metrics and terminology varied throughout investigations, there was little room for meta-analysis.

The Figure (1): Shows the selection procedure for the study. The inclusion criteria were met by 13 publications.

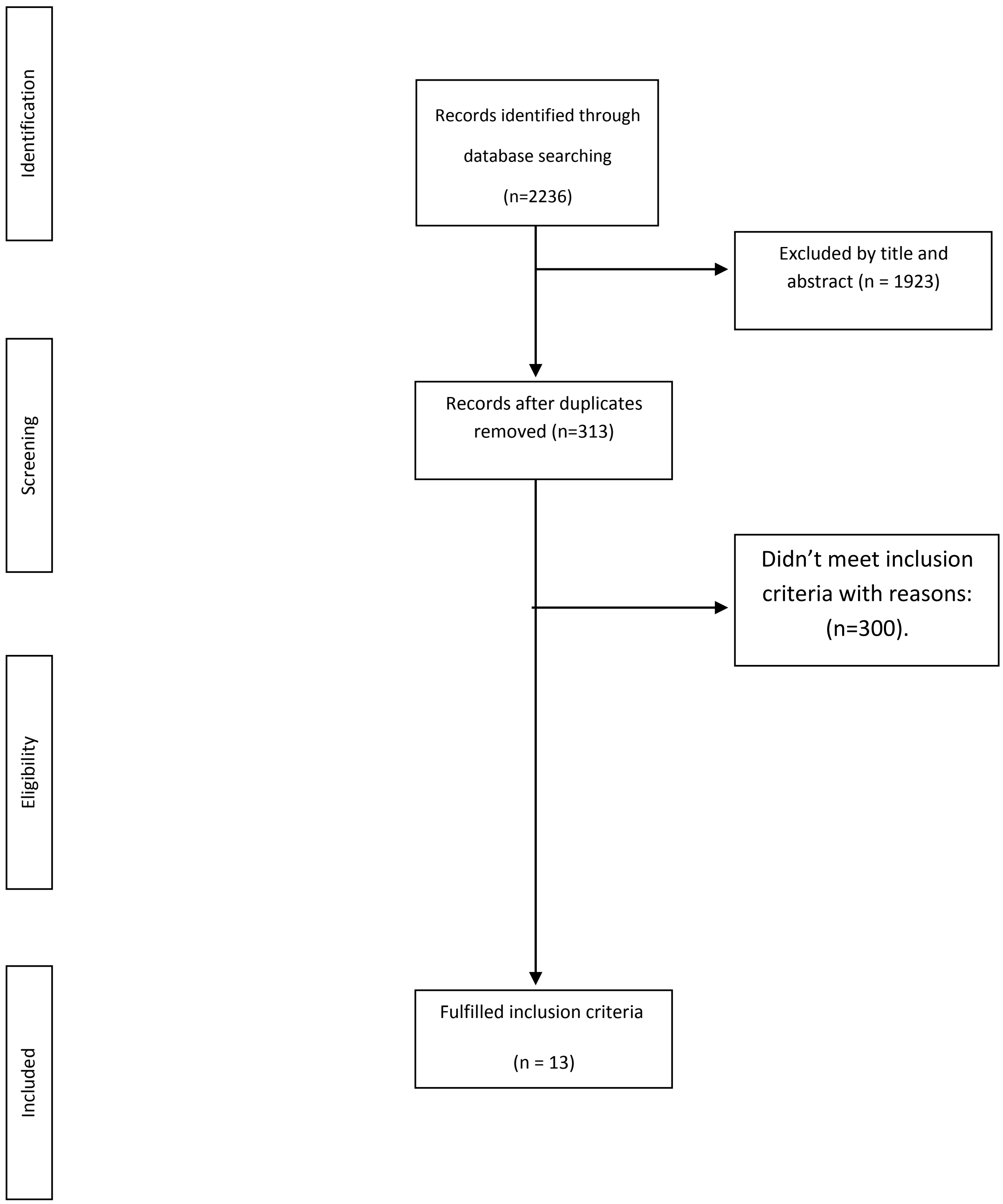

Figure (1): Flow chart for the literature search

Table (1): General characteristics of the included studies

Studies (chronologically ordered)	Age range	Participants' cohorts (n)	Elderly participants	How 'healthy' is it?	Medications?	Instrumental evaluation	Swallowing tasks (bolus size, textures)	Objective of the study
Khan et al. [47]	From 20 to 89 years	From 20 to 39 years (43) From 60 to 89 years (49)	Not mentioned	Interview: 'carefully questioned'	Not mentioned	LOWER-RESOLUTION MANOMETRY	5 ml of water in boluses, overall unknown	Age-related changes to esophageal motility
Dejaeger et al. [18]	Not mentioned	Healthy participants (20) Older (16)	80 years, 5 years	No pertinent background	Not mentioned	VIDEOFLUOROSCOPY LOWER-RESOLUTION MANOMETRY	3 to 10 cc or more of liquids barium.	Measurements of swallowing that are quantitative and qualitative are affected by age
Rademaker et al. [19]	From 20 to 89 years	From 20 to 39 years (61) From 40 to 59 years (45) From 60 to 79 years (38) From 80 to 89 years (23)	Not mentioned	No pertinent background	Monitored	VIDEOFLUOROSCOPY	2 × 1, 3, 5 and 10 ml liquid barium	Influence of bolus size and age on the ability to swallow normally
Logemann et al. [20]	From 21 to 94 years	From 21 to 29 years (8) From 80 to 94 years (8)	Not mentioned	No pertinent background	Monitored	VIDEOFLUOROSCOPY	2 × 1 and 10 ml liquids bariums	Duration and biomechanical of swallowing are affected by ageing.

Yokoyama et al. [21]	From 21 to 89 years	From 21 to 31 years (32) From 61 to 74 years (12) From 75 to 89 years (12)	Not mentioned	Not mentioned: 'non-dysphagic'	Not mentioned	LOWER-RESOLUTION MANOMETRY VIDEOFLUOROSCOPY	10 ml liquids bariums	Age-related changes in swallowing performance and pressure
Leonard et al. [22]	From 18 to 88 years	younger (84) Eldest (88)	Median 70 years	Questionnaire, HEENT examination, and dietary survey.	Taken for persistent elderly diseases under observation	VIDEOFLUOROSCOPY	Lateral: 20 ml fluid bolus, 1 and 3 ml paste. 20 ml fluid bolus from anterior to posterior.	Age has an impact on UES openings. UES openings and swallowing occurrences in related.
Martin-Harris et al. [23]	Not mentioned	All healthy (76)	Not mentioned ≥81 years	Interviews, questionnaires	Monitored	VIDEOFLUOROSCOPY	2 × 5 ml liquids bariums	Typical respiratory rates and the timing of breathing and swallowing.
Yoshikawa et al. [24]	From 24 to 87 years	Youngest (14) Older (19)	81.2 years	Questionnaires, interviews, repetitive saliva swallowing tests	Not mentioned	VIDEOFLUOROSCOPY	3 ml of the barium solutions and 3 × 10 ml of the barium solutions.	Aging's impact on swallowing
Cock et al. [25]	From 20 to 93 years	Youngest (30) Elderly (15)	85 years, 4 years	No pertinent background, questionnaires	Monitored	HIGH-RESOLUTIONS MANOMETRY WITH IMPEDANCES	5 × 5 and 10 ml liquid and viscous bolus	Age-related changes in bolus elimination and esophageal physiological processes

Cock et al. [26]	From 20 to 91 years	Youngest (50) Elderly normal (16) Patients (27)	85 years, 4 years	Interviews, questionnaires	Monitored	HIGH-RESOLUTIONS MANOMETRY WITH IMPEDANCES	5 × 5 ml liquids and viscous boluses	Age-related comparisons of UES functions in patients (with limited UES openings) and control subjects
Cock et al. [49]	From 20 to 93 years	Youngest (30) Older (15)	85 years, 4 years	No pertinent background, questionnaires	Monitored	HIGH-RESOLUTIONS MANOMETRY WITH IMPEDANCES	Fluid and viscous boluses of 5 × 5 and 10 ml each	Analyzing the functionality of the esophagogastric junctions and the impact of age
Jardine et al. [27]	From 20 to 99 years	Young (45) Elderly >seventy year s (59) Patients (55)	81.2 years, 8.18 years	Questionnaires	Not mentioned	VIDEOFLUOROSC OPY	1, 3, 20, 100 ml fluid bariums, 3 ml bariums paste, lateral views. 20 ml fluid bariums, 3 ml paste, and tablet, A-P views.	Comparing quantitative swallow tests in elderly patients with new-onset dysphagia and normal persons.
Ayala and Logemann [28]	From 20 to 90 years	From 20 to 30 years (10) From 60 to 70 years (10) From 80 to 90 years (10)	83.7 years	Self–reported	Not mentioned	VIDEOFLUOROSC OPY	45 swallows altogether, encompassing water, colder, thinner, paste, sour, and cold and sour flavours.	Effects of bolus sensory features (heating, flavour, texture), as well as ongoing use, on swallowing.

Table (2): Delayed onset of swallowing

Paper	Assessments	Measures	Authors' definitions	Old aging
Rademaker et al. [19]	Video fluoroscopy	Pharyngeal delayed time	From the bolus heads through the mandibular ramus to the beginning of laryngeal advancement.	↑
Logemann et al. [20]	Video fluoroscopy	Pharyngeal delayed	Initial laryngeal elevating in swallow is observed from the bolus head approaching point where the bottom edge of the mandible meets the base of the tongue.	↑
Yoshikawa et al. [24]	Video fluoroscopy	Pharyngeal delay time	Commences at the point where the lower edge of the mandibular passes the base of the tongue, and finishes when laryngeal elevating starts in relation to the rest of the swallow.	↑
Ayala and Logemann [28]	Video fluoroscopy	Pharyngeal delayed time	Variation between the beginning of laryngeal rise and the point at which the bolus head crosses the inferior border of the mandibular and the base of the tongue.	⇡*
Cock et al. [26]	High-resolutions manometry with impedances	Flow interval	Length of the distal pharynx's impedance decline.	↑

↑ Elevation that is statistically relevant is seen in elderly persons; – no observable age-related changes; ⇡ elderly people were found to have increased, although it wasn't statistically meaningful; *effects of use: Towards the end of swallow sets, a consistent increase was noticed among the elderly and the elderly.

Table (3): Transit times for bolus

Paper	Assessments	Measures	Authors' definitions	Old aging
Dejaeger et al. [18]	lower-resolution manometry, Video fluoroscopy	Oropharyngeal transit time	Length between the first and secondary sensors' passing time.	–
		Hypopharyngeal transit time	Length between the second and fourth sensors' passing time.	–
		Pharyngeal transitting time	the interval between the bolus head's entry at the first sensor and its transit through the fourth sensor. The length of the bolus's pharyngeal entry.	–
Rademaker et al. [19]	Video fluoroscopy	Oral transit time	From the moment the tongues start to move, pushing the bolus backward, till the bolus head reaches the ramus of the mandibular.	–
		Pharyngeal transit time	Bolus tail enters through cricopharyngeal sphincters after bolus heads enters through ramus of mandibles.	↑
Yokoyama et al. [21]	lower-resolution manometry, Video fluoroscopy	Oropharyngeal transiting	Temporal segmentation time between when the bolus head contacts a particular sensor to when the bolus tail departs from that same detector.	↑
		Hypopharyngeal transit		↑
		Upper esophageal sphincter (UES) transiting		↑
		Pharyngeal transiting time	length from when the bolus head contacts the oropharyngeal sensors to when the bolus tail departs from the UES detector.	↑
Leonard et al. [22]	Video fluoroscopy	Hypopharyngeal transiting time	the interval between the bolus tail passing the UES and the bolus head leaving or passing the valleculae.	↑
Martin-Harris et al. [23]	Video fluoroscopy	Total swallowing time	Not otherwise described.	⇡
Yoshikawa et al. [24]	Video fluoroscopy	Oral transiting time	Duration of tongue movements before the start of the voluntary oral phase until the tail of the bolus reaches the point where the lower edge of the jaw meets the bases of the tongues.	↑
		Pharyngeal transiting time	the interval between the start of the pharyngeal swallowing and the moment the bolus' tail enters the cricopharyngeal area.	↑
Jardine et al. [27]	Video fluoroscopy	Total pharyngeal transiting time	Swallowing begins (initial movements past the posterior nasal spines) and continues until the bolus tail is cleared through the pharyngoesophageal segments (PES).	↑
		Esophageal transiting time	Bolus entry through PES to decrease esophageal sphincter clearances	↑

↑ significantly more senior persons, according to statistics; ↓ among older individuals, a statistically meaningful decline was seen; – no observable age-related changes; ⇡ elderly people were found to have increased, although it wasn't statistically significant; * considerable, age-related, consistent growth in pharyngeal transit time till ≥ 80 years.

Table (4): Measurements of hyoid displacement and time

Paper	**Assessments**	**Measures**	**Authors' definitions**	**Old aging**
Displacement				
Logemann et al. [20]	Video fluoroscopy	Anterior hyoid movements	From a sitting positioning to the highest elevations.	↓
		Hyoid elevation	Maximum elevations from the seated posture.	↓
Leonard et al. [22]	Video fluoroscopy	Hyoid displacement (Hmax)	At baseline and once more at the point of its largest departure from standard during swallowing, the hyoids positioning was measured.	–
Jardine et al. [27]	Video fluoroscopy	Hmax	Hyoid positioning shifts from neutral to the most anterior positioning No observable age-related changes backward displacements	–
Duration				
Rademaker et al. [19]	Video fluoroscopy	Time of hyoid movements	interval between the hyoid bone's beginning of motion and returning to rest.	–*
Jardine et al. [27]	Video fluoroscopy	Hdur	Greatest hyoid movement time durations	–

↑ significantly more senior persons, according to statistics; ↓ among elderly individuals, a statistically significant decline was seen; – without observable age-related changes; ⇡ older persons were found to have increased, although it wasn't statistically significant; ⇣ elderly people were found to have decreased, although it wasn't statistically significant; *Hyoid movements lasted longer in people 60 to 79 years old, and less long in people 80 to 89 years old.

Table (5): Airway measurments

Paper	Assessments	Measures	Authors' definitions	Older aging
Hyolaryngeal movements				
Logemann et al. [20]	Video fluoroscopy	Anterior laryngeal movements	Laryngeal positioning was evaluated in respect to the second cervical vertebra's anterior-inferior region when at relaxation.	–
		Laryngeal elevation	Maximum structural mobility, as yet undefinable.	↓
Jardine et al. [27]	Video fluoroscopy	HLmax	Discrepancy between the hyoid and larynx's distances when they are at resting and when they are closest together during swallowing	↓
Timing				
Rademaker et al. [19]	Video fluoroscopy	Time of laryngeal closures	Duration of lateral planes closure of the laryngeal opening between the arytenoids and the base of the epiglottis throughout swallowing.	↑
		Time of laryngeal elevations	The interval between the start of laryngeal elevating and laryngeal relaxation.	↑
Logemann et al. [20]	Video fluoroscopy	Laryngeal closures	Not determined	-
Ayala and Logemann [28]	Video fluoroscopy	Time of laryngeal closure	When swallowing, the laryngeal entry (located between the arytenoids and the base of the epiglottis) is blocked.	↑
		Duration of laryngeal elevations	Not reported	⇡
Jardine et al. [27]	Video fluoroscopy	Airwaycl	The beginning and end of supraglottic closures.	–
		Airwaydur	The length of airway closure	–

↑ significantly more senior persons, according to statistics; ↓ among elderly individuals, a statistically significant decline was seen; – no observable age-related changes; ⇡ elderly people were found to have increased, although it wasn't statistically significant; * only in older females with cricopharyngeal bars was there a substantial increase.

Table (6): Pharyngeal constrictions, duration, and pressure measurement's

Paper	**Assessments**	**Measures**	**Authors' definitions**	**Old aging**
Constrictions				
Leonard et al. [22]	Video fluoroscopy	Unobliterated pharynx spacing	At the instant of maximal pharyngeal clearance while swallowing, a portion of the pharynx is still present.	↑
Jardine et al. [27]	Video fluoroscopy	Proportion of pharynx constriction.	Optimum contraction of the pharynx and the open pharynx.	–
Timing				
Yokoyama et al. [21]	lower-resolution manometry, Video fluoroscopy	Period of oropharyngeal pressures	For how long does oropharyngeal positively pressure last?	↑
		length of the hypopharyngeal pressures	How long does hypopharyngeal positive pressure last?	↑
Cock et al. [26]	High-resolutions manometry with impedances	TNIPP	Duration from the nadir resistance to the peak pressure is the distension-contractions latency, according to Cock.	–
Pressure				
Dejaeger et al. [18]	lower-resolution manometry, Video fluoroscopy	Pharyngeals Cont raction's Amplitudes	Undefined elevation of the pharyngeal constriction peaks.	–
Yokoyama et al. [21]	lower-resolution manometry, Video fluoroscopy	Pmax oropharynx	The oropharyngeal pressure's optimum values.	⇡
		Pmax of the hypopharynx	highest possible level of hypopharyngeal pressures.	⇡
Cock et al. [26]	High-resolutions manometry with impedances	PeakP	Maximum pressure in the throat	⇡

↑ Growth that is statistically significant is seen in elderly persons; – no observable age-related changes; ⇡ elderly people were found to have increased, although it wasn't statistically significant.

Table (7): UES opening, period, and pressure measurements

Paper	**Assessments**	**Measures**	**Article' definitions**	**Elderly aging**
UES opening				
Logemann et al. [20]	Video fluoroscopy	Cricopharyngeal opening width.	largest possible structural movements	↓
Leonard et al. [22]	Video fluoroscopy	UESmax-lat, the maximal UES aperture.	the cervical vertebrae three and 6's lowest position, as evaluated at its widest point during swallowing.	–*
		UESmax-a/p	The previous measurement is duplicated in the front. No observable age-related changes the back view.	–**
Cock et al. [26]	High-resolutions manometry with impedances	UES Max Adm	Greatest admittances for UES at its largest diameter.	↓
Jardine et al. [27]	Video fluoroscopy	PESmax	Greatest PES distensions.	–
Timing				
Rademaker et al. [19]	Video fluoroscopy	Cricopharyngeal open ing time durations	Duration of every swallowing with the cricopharyngeal area opened.	↑
Logemann et al. [20]	Video fluoroscopy	Aperture of the cricothyra	Maximum structural mobility, as yet undefinable.	–
Yokoyama et al. [21]	lower-resolution manometry, Video fluoroscopy, Video fluoroscopy	Period of UES relaxing.	time interval between Pmin (pressure becoming minimum) and the point at which UES pressure starts to increase with UES contractions.	–
Leonard et al. [22]	Video fluoroscopy	UES opened	Overall time the UES was open while swallowing.	↑
Ayala and Logemann [28]	Video fluoroscopy	Cricopharyngeal open time durations.	From the beginning of openings until the tails of the bolus departs the cricopharyngeal area, the cricopharyngeal area is opened while swallowing.	↑#
Jardine et al. [27]	Video fluoroscopy	PESop	PES open time	–
Pressure above UES				

Cock et al. [26]	High-resolutions manometry with impedances	PNadImp	The intrabolus pressure in the hypopharynx	↑
Relaxation pressure				
Yokoyama et al. [21]	lower-resolution manometry, Video fluoroscopy, Video fluoroscopy	UES Pmin	Minimal UES pressure level	↑
Cock et al. [26]	High-resolutions manometry with impedances	IRP0.2	Average of the minimum pressures measured over 0.2 cumulative seconds for the UES-integrated relaxing pressure.	↑

↑ Improvement that is statistically significant is seen in elderly persons; ↓ among elderly individuals, a statistically significant decline was observed; – no observable age-related changes; * reduction that is discernible in elderly people with cricopharyngeal bars; ** for elderly men with cricopharyngeal bars, there is a considerable reduction; *** A shorter UES opening is indicated by increasing UES Zn; # consequences: In the final swallowing set, older people had higher CP durations than extremely elderly people.

Table (8): Esophageal pressure measurments

Paper	**Assessments**	**Measures**	**Authors' definitions**	**Old aging**
Pressures-flow analysing				
Cock et al. [25]	High-resolutions manometry with impedances	PeakP	Maximum pressure, not otherwise specified.	–
Khan et al. [47]	lower-resolution manometry	Esophageal contractions intensity	Not thereby described	↓*
Cock et al. [25]	High-resolutions manometry with impedances	PNadImp	Pressure at nadir impedances,	↑
Cock et al. [25]	High-resolutions manometry with impedances	IBP	Intrabolus pressure	↑
Cock et al. [25]	High-resolutions manometry with impedances	IBP slope	internal pressure gradient (reflects the ratio at which pressure increased)	↑
Cock et al. [25]	High-resolutions manometry with impedances	TNIPP	From bolus distensions to esophagus contractions, the delay from nadir resistance to peak pressures is measured.	⇡
Khan et al. [47]	lower-resolution manometry	lengths of the stages of contractions and relaxations.	Not thereby described	–
Khan et al. [47]	lower-resolution manometry	Relaxing esophagus pressure	Not thereby described	–**
Cock et al. [25]	High-resolutions manometry with impedances	PFI	Measure of pressure-flow.	–
Cock et al. [25]	High-resolutions manometry with impedances	IR	Impedances ratios: ratios of the resistance at the lowest point to the resistance at the pressure maximum.	↑

Chicago variables				
Cock et al. [25]	High-resolutions manometry with impedances	IRP4	Combined relaxing pressure over four seconds.	↑
Cock et al. [25]	High-resolutions manometry with impedances	ICD	Axial lengths of faults in the 20-mmHg isobaric contours, also known as an isocontours deficiency or peristaltic breaking lengths.	↑
Cock et al. [25]	High-resolutions manometry with impedances	CFV	Slope of the tangential between the proximate transition region and the contractual decelerations point that approximates the 30 mmHg isocontour is the contractile front velocities.	↑
Cock et al. [25]	High-resolutions manometry with impedances	DCI	Distal esophagus segments as amplitude, time, and extent of the contractions more than 20 mmHg is known as the distal contractile integral.	–
Cock et al. [25]	High-resolutions manometry with impedances	DL	Distal delay is the amount of time between the beginning of the swallowing and the contractile decelerate level (either through UES relaxing or the beginning of impedance decline at the most proximal channels).	–
LES				
Khan et al. [47]	lower-resolution manometry	LES contracting amplitudes.	LES contractions amplitudes in reaction to deglutition.	↓
		LES relaxing	LES relaxing amplitudes in reaction to deglutition.	–
Measurements of the esophagogastric junctions				
Cock et al. [49]	High-resolutions manometry with impedances	IRP4	Combined relaxing pressure at the esophagogastric junctions after four seconds	↑
Cock et al. [49]	High-resolutions manometry with impedances	GasP	Not thereby described	↑
Cock et al. [49]	High-resolutions manometry with impedances	BFT	Timing of bolus release.	↓
Cock et al. [49]	High-resolutions manometry with impedances	BPT	Time of bolus existence: bolus in the distal esophagus.	↓

↑ Elevation that is statistically significant is seen in elderly persons; ↓ among elderly individuals, a statistically significant decline was seen; – no observable age-related changes; * greatly diminished in the lower and upper thirds of the oesophagus; ** much higher rates for older women.

Table (9): Description of events found to cause penetrating and aspirations in researches

Paper	Assessments	Penetrations	Old age	Aspirations	Old age
Dejaeger et al. [18]	lower-resolution manometry, Video fluoroscopy	Not described	/	Younger: undetectable 1/16 patients are elderly.	*
Martin-Harris et al. [34]	Video fluoroscopy	The majority of research respondents lacked laryngeal penetrations.	*	The majority of individuals in this research lacked aspirations.	*
Yoshikawa et al. [24]	Video fluoroscopy	Young: 0/14 Older: 6/19	↑	Not detected	–
Ayala and Logemann [28]	Video fluoroscopy	Younger: 7.9% Older: 19.1% Very old: 17.5%	*	Younger: 1 person Older: 0 Very old: 3 (5 swallows)	↑
Jardine et al. [27]	Video fluoroscopy	Younger: not reported Older: 3 (5.4%) patients	*	Not reported	–

/ Unknown; – not reported; * found, however there was no specific age-related variation; ↑ discovered and predicted to rise as people get older.

Table (10): Characteristics of pharyngeal residue detected in studies

Paper	Assessments	Residues of the pharynx	Old age
Dejaeger et al. [18]	lower-resolution manometry, Video fluoroscopy	Younger: not determined Older: pyriforms 10/16 subjects and vallecular 11/16.	↑
Rademaker et al. [19]	Video fluoroscopy	Oral, Age 20-39: 10.1% swallowing 80–89 years: 29.2%	↑
	Video fluoroscopy	Pharyngeal, 20–39 years:18.0% 80–89 years: 38.0%	↑
Logemann et al. [20]	Video fluoroscopy	All ages, zero or mild Younger: Usually leaves no traces Older: more frequently observed light remnant.	*
Yoshikawa et al. [24]	Video fluoroscopy	Oral, Younger:4/14 Older: 13/19	↑

	Video fluoroscopy	Pharyngeal, Younger:0/14 Older: 8/19	↑
Ayala and Logemann [28]	Video fluoroscopy	At normal ranges, minimal/trace quantities (0–3%), consistent across age categories.	*
Jardine et al. [27]	Video fluoroscopy	Quantification of the residues showed no age-related changes.	*

* Identified but no specific age-related changes were discovered; ↑ identified and predicted to rise as people get older.

Table (11): Risk of bias evaluation using a modified version of the Cochrane Collaboration's instrument

Study	**Attrition**	**Detection**	**Other sources of bias**		
			Reliability	**Instruction**	**Bolus**
Dejaeger et al. [18]	–	–	–	–	1 bolus capacity
Rademaker et al. [19]	–	–	✓	–	Standard order
Cock et al. [25]	–	–	–	Cued	–
Martin-Harris et al. [23]	Low	–	–	Uncued	1 bolus capacity
Jardine et al. [27]	Low	–	–	–	Standard order
Cock et al. [49]	–	–	–	Cued	–
Logemann et al. [20]	–	–	✓	–	–
Yokoyama et al. [21]	–	–	–	–	1 bolus capacity
Ayala and Logemann [28]	Low	Low	✓	Cued	Randomized
Khan et al. [47]	–	–	–	–	1 bolus capacity
Leonard et al. [22]	–	–	✓	–	Standard order
Yoshikawa et al. [24]	–	–	Findings mentioned	Cued	1 bolus capacity
Cock et al. [26]	–	–	–	Cued	–

- Unclear risk of bias; ✓ tested.

Discussion

This study was carried out in response to the requirement to comprehend alterations in healthy old people (> eighty five years old) as a result of the world's ageing population. There was still a substantial body of research that examined age-related swallowing alterations into the eighth century and beyond using a range of instrumental measurements, even after 96% of available studies were excluded because the oldest old were not enrolled. The 13 investigations that were considered were divided into three quarters pharyngeal measurements, five esophagus assessments only, and six assessments of penetrating, aspirations, or pharyngeal residues. While age-related alterations in swallows were noted across all parameters, older age was more consistently linked to variations in the timing of the swallow, the length of the UES aperture, the pressure above the UES, the UES relaxing pressure, and the decrease of pressure at the UES. The timing and movement measurements of the hyoids and larynx were inconclusive. Few researchers suggest airway impairment in healthy older persons as increasing aspiration or residue.

Effects of Age on Swallowing :

It has been discussed how age-related physiologic, anatomic, and neurologic factors impact an older person's ability to swallow. In studies employing fMRI during swallowing activities, older people showed increased cortical [30] and subcortical involvement in addition to decreased activation of sensory processes and sensorimotor interaction [31]. Sarcopenia, or the age-related decrease of muscular mass and functioning, affects persons 85 years of age and older and has been directly correlated to difficulty swallowing [31-33]. On MRI, it was discovered that normal elderly people had thinner pharyngeal walls and larger pharyngeal lumens [34]. Although individuals in all included trials were deemed to be in good health, it is uncertain how many sarcopenia risk factors had. Future studies involving the oldest elderly should take into account this emerging field of study. Additional aging-related structural alterations included osteophytes and non-obstructive cricopharyngeal bars in the spine [35]. Cricopharyngeal bars have not been shown to affect hypopharyngeal transit times, the length of the UES opening [36], the maximal admission, or the 0.2 s integrated relaxing pressure [26].

Quality :

Every research included at least one source with an uncertain bias risk. It is crucial that evaluators are blind to participants age when studying age impacts, yet only 20% of research included information on blinding procedures in their findings. Instrumental evaluations run the possibility of human mistake, including blurry images and missing recordings. The fact that just 39% of investigations provided information about missing data is remarkable. Less than half (45%) of studies included reliability analysis information. Despite the widespread adoption and reporting of standard techniques, cross-study assessments were challenging because of variations in sample sizes, age ranges, and criteria for classifying individuals as "healthy." Consequently, a meta-analysis was not advised.

The criteria used to judge respondents to be "healthy" varied substantially between investigations. To maximise the reliability and applicability of outcomes and to prevent bias, it is crucial to use standardised questionnaires or to clarify the procedures used to examine medical history. Elderly adults use more medications [37], and medications have been shown to affect swallowing [38]. As a result, it is crucial to evaluate all prescription drugs when evaluating for healthier older persons.

Oldest Old :

Globally, there are various definitions of old age that change depending on economic, socially, and political variables [39]. All of the investigations that made up this systematic review were carried out in industrialised nations including New Zealand, Belgium, Canada, England, Brazil, Korea, The Netherlands, Japan, the USA and Australia that were also undergoing accelerated ageing. Our results might only apply to nations with comparable life expectancy levels. Despite the fact that individuals over the age of 85 were recruited for all trials, the age demographics and fraction of oldest old were sometimes poor and uncertain. Several publications either excluded the age range or presented the age range without the mean age. This systematic review shows that the maximum age for research has increased over time, indicating that scientists are addressing the ageing population and the necessity to include persons over the age of 85 in their study. To accurately reflect the ageing tendencies of communities and nations, future studies should as strive for equal proportions of persons over eighty five years old in addition to a maximum age in the 90s or 100s.

Measuring Swallowing Physiology :

VFS was used in the largest number of studies from the 1990s to 2018 (8/13) owing to quantitative analysis, which has shown its continued dependability and relevance [40]. Visual physiology and pressure topography, which are offered by contemporaneous VFS and manometry (manofluorography), are only mentioned in previous publications in this study [18, 21]. With four papers comprised of this evaluation since 2014, HRIM is a novel evaluation. The instructions, volume, and viscosity of oral trials for swallowing varied between researches. Swallowing activities were performed less frequently during VFS, especially in early investigations. Regarding our knowledge of changes in bolus positioning during cued swallowing [41] and influence on analyses, in addition to comparability of bolus timings data, lower than half of publications specified if swallowing activities were cued or non-cued.

As mentioned in earlier systematic reviews [42-44], the numerous terminologies and descriptions for swallowing measurements make comparisons between publications more difficult (Tables 2, 3, 4, 5, 6, 7, 8, 9, 10). Future research should use standardised processes and swallowing tasks to guarantee outcomes are comparable, especially for demographics that are challenging to enrol, such the elderly.

Limitations :

Measurements were taken, and differences between young and elderly were presented if there were any between-group discrepancies on any bolus categories. Each study assessed the proportion of people over 85 in accordance with the research topic.

Conclusions :

The timing of bolus entry into the pharynx relative to swallow commencement was found to be delayed with age, as were bolus transit times, the length of the UES aperture, pressures above the UES, UES relaxing pressure, and lower pressure at the UES. There is inadequate proof that these alterations make healthy elderly people sicker. There is a substantial amount of research documenting alterations in swallowing that are connected to ageing and are attributed to neurologic, anatomical, and physiological variables. But as people age, swallowing effectiveness increases. According to this review, risk indicators including aspirations and pharyngeal residues may rarely occur but are not always indicative of ageing. It is not appropriate to consider significant variations from established normative swallowing metrics in older persons as a result of normal ageing. The amount of persons over 85 years old represented in deglutition studies, in addition to study design and bias, limit results when looking at particular changes for the eldest aged. Considering that the world's population is ageing, we need to improve our understanding of swallowing in the very old. Future research must include healthy individuals and adults over 85 with dysphagia as study participants.

References :

1. Schindler, J.S. and J.H. Kelly, Swallowing disorders in the elderly. The Laryngoscope, 2002. 112(4): p. 589-602.
2. Wang, C.M., et al., Aging-related changes in swallowing, and in the coordination of swallowing and respiration determined by novel non-invasive measurement techniques. Geriatrics & gerontology international, 2015. 15(6): p. 736-744.
3. Mancopes, R., et al., Which physiological swallowing parameters change with healthy aging? OBM geriatrics, 2021. 5(1).
4. Mulheren, R.W., et al., Swallowing changes in community-dwelling older adults. Dysphagia, 2018. 33(6): p. 848-856.
5. Hutchison, A.R., et al., Exploring the interplay between radiotherapy dose and physiological changes in the swallowing mechanism in patients undergoing (chemo) radiotherapy for oropharynx cancer. Dysphagia, 2022. 37(3): p. 567-577.
6. Azola, A., et al., Dysphagia in myositis: a study of the structural and physiologic changes resulting in disordered swallowing. American Journal of Physical Medicine & Rehabilitation, 2020. 99(5): p. 404-408.
7. Namasivayam-MacDonald, A.M., et al., A retrospective analysis of swallowing function and physiology in patients living with dementia. Dysphagia, 2022. 37(4): p. 900-908.
8. Balou, M., et al., An intensive swallowing exercise protocol for improving swallowing physiology in older adults with radiographically confirmed dysphagia. Clinical interventions in aging, 2019. 14: p. 283.
9. Newman, R., et al., Effect of bolus viscosity on the safety and efficacy of swallowing and the kinematics of the swallow response in patients with oropharyngeal dysphagia: white paper by the European Society for Swallowing Disorders (ESSD). Dysphagia, 2016. 31(2): p. 232-249.
10. Molfenter, S.M., et al., Alterations to swallowing physiology as the result of effortful swallowing in healthy seniors. Dysphagia, 2018. 33(3): p. 380-388.
11. Berretin-Felix, G., et al., Immediate effects of transcutaneous electrical stimulation on physiological swallowing effort in older versus young adults. Gerodontology, 2016. 33(3): p. 348-355.
12. Mekata, K., et al., The effect of the cervical orthosis on swallowing physiology and cervical spine motion during swallowing. Dysphagia, 2016. 31(1): p. 74-83.

13. Tanaka, N., et al., Swallowing frequency in elderly people during daily life. Journal of oral rehabilitation, 2013. 40(10): p. 744-750.
14. Sasegbon, A. and S. Hamdy, The anatomy and physiology of normal and abnormal swallowing in oropharyngeal dysphagia. Neurogastroenterology & Motility, 2017. 29(11): p. e13100.
15. Park, H.S., et al., The effect of aging on mastication and swallowing parameters according to the hardness change of solid food. Journal of texture studies, 2017. 48(5): p. 362-369.
16. Lefebvre, C., et al., Cochrane handbook for systematic reviews of interventions. Oxfordshire, UK: The Cochrane Collaboration, 2011.
17. Balshem, H., et al., GRADE guidelines: 3. Rating the quality of evidence. Journal of clinical epidemiology, 2011. 64(4): p. 401-406.
18. Dejaeger, E., et al., Manofluorographic analysis of swallowing in the elderly. Dysphagia, 1994. 9(3): p. 156-161.
19. Rademaker, A.W., et al., Age and volume effects on liquid swallowing function in normal women. Journal of Speech, Language, and Hearing Research, 1998. 41(2): p. 275-284.
20. Logemann, J.A., et al., Temporal and biomechanical characteristics of oropharyngeal swallow in younger and older men. Journal of Speech, Language, and Hearing Research, 2000. 43(5): p. 1264-1274.
21. Yokoyama, M., et al., Role of laryngeal movement and effect of aging on swallowing pressure in the pharynx and upper esophageal sphincter. The Laryngoscope, 2000. 110(3): p. 434-439.
22. Leonard, R., K. Kendall, and S. McKenzie, UES opening and cricopharyngeal bar in nondysphagic elderly and nonelderly adults. Dysphagia, 2004. 19(3): p. 182-191.
23. Martin-Harris, B., et al., Breathing and swallowing dynamics across the adult lifespan. Archives of Otolaryngology–Head & Neck Surgery, 2005. 131(9): p. 762-770.
24. Yoshikawa, M., et al., Aspects of swallowing in healthy dentate elderly persons older than 80 years. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 2005. 60(4): p. 506-509.
25. Cock, C., et al., Impaired bolus clearance in asymptomatic older adults during high-resolution impedance manometry. Neurogastroenterology & Motility, 2016. 28(12): p. 1890-1901.
26. Cock, C., et al., Maximum upper esophageal sphincter (UES) admittance: a non-specific marker of UES dysfunction. Neurogastroenterology & Motility, 2016. 28(2): p. 225-233.
27. Jardine, M., A. Miles, and J. Allen, Dysphagia onset in older adults during unrelated hospital admission: quantitative videofluoroscopic measures. Geriatrics, 2018. 3(4): p. 66.
28. Ayala, K.J. and J.A. Logemann, Effects of altered sensory bolus characteristics and repeated swallows in healthy young and elderly subjects. Journal of Medical Speech-Language Pathology, 2010. 18(3): p. 34-59.
29. Leonard, R., P.C. Belafsky, and C.J. Rees, Relationship between fluoroscopic and manometric

measures of pharyngeal constriction: the pharyngeal constriction ratio. Annals of Otology, Rhinology & Laryngology, 2006. 115(12): p. 897-901.

30. Humbert, I.A., et al., Neurophysiology of swallowing: effects of age and bolus type. Neuroimage, 2009. 44(3): p. 982-991.
31. Malandraki, G.A., et al., Reduced somatosensory activations in swallowing with age. Human brain mapping, 2011. 32(5): p. 730-743.
32. Dodds, R.M., et al., Prevalence and incidence of sarcopenia in the very old: findings from the Newcastle 85+ Study. Journal of cachexia, sarcopenia and muscle, 2017. 8(2): p. 229-237.
33. Zhao, W.-T., et al., Systematic review and meta-analysis of the association between sarcopenia and dysphagia. The journal of nutrition, health & aging, 2018. 22(8): p. 1003-1009.
34. Molfenter, S.M., et al., Age-related changes in pharyngeal lumen size: a retrospective MRI analysis. Dysphagia, 2015. 30(3): p. 321-327.
35. Yin, T., et al., What is a normal pharynx? A videofluoroscopic study of anatomy in older adults. European Archives of Oto-Rhino-Laryngology, 2018. 275(9): p. 2317-2323.
36. Omari, T.I., et al., A method to objectively assess swallow function in adults with suspected aspiration. Gastroenterology, 2011. 140(5): p. 1454-1463.
37. Sergi, G., et al., Polypharmacy in the elderly. Drugs & aging, 2011. 28(7): p. 509-518.
38. Stegemann, S., M. Gosch, and J. Breitkreutz, Swallowing dysfunction and dysphagia is an unrecognized challenge for oral drug therapy. International journal of pharmaceutics, 2012. 430(1-2): p. 197-206.
39. Ward, S.A., S. Parikh, and B. Workman, Health perspectives: international epidemiology of ageing. Best Practice & Research Clinical Anaesthesiology, 2011. 25(3): p. 305-317.
40. Kendall, K.A., et al., Objective measures of swallowing function applied to the dysphagia population: a one year experience. Dysphagia, 2016. 31(4): p. 538-546.
41. Nagy, A., et al., Timing differences between cued and noncued swallows in healthy young adults. Dysphagia, 2013. 28(3): p. 428-434.
42. Cock, C. and T. Omari, Systematic review of pharyngeal and esophageal manometry in healthy or dysphagic older persons (> 60 years). Geriatrics, 2018. 3(4): p. 67.
43. Namasivayam-MacDonald, A.M., C.E. Barbon, and C.M. Steele, A review of swallow timing in the elderly. Physiology & behavior, 2018. 184: p. 12-26.
44. Winiker, K., et al., A systematic review of current methodology of high resolution pharyngeal manometry with and without impedance. European Archives of Oto-Rhino-Laryngology, 2019. 276(3): p. 631-645.