

## Review articles

# Kinematic measures of swallowing obtained with ultrasound: a scoping review protocol

**Giovanna da Silva Martins**<sup>1</sup><https://orcid.org/0000-0002-2835-4295>**Jayne de Freitas Bandeira**<sup>1</sup><https://orcid.org/0000-0002-8066-2201>**Maria Sá Gurgel Linhares Alves**<sup>1</sup><https://orcid.org/0000-0003-0013-3869>**Bianca Oliveira Ismael da Costa**<sup>1</sup><https://orcid.org/0000-0002-7541-4350>**Leandro Pernambuco**<sup>1</sup><https://orcid.org/0000-0001-6246-9769>

<sup>1</sup> Universidade Federal da Paraíba - UFPB, João Pessoa, Paraíba, Brasil.

Conflict of interests: Nonexistent



## ABSTRACT

**Purpose:** to identify and synthesize scientific evidence on kinematic measures of swallowing obtained with ultrasound.

**Methods:** a protocol following the methodology proposed by the Joanna Briggs Institute and the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols – extension for scoping reviews (PRISMA-ScR). The search will be made in PubMed/MEDLINE, Scopus, Web of Science, LILACS, ScienceDirect, Embase, and Google Scholar, using a search strategy developed for PubMed/MEDLINE, which will be adapted for each database. Articles will be initially screened by title and abstract by two independent reviewers who will read their full text according to the eligibility criteria. Data in included articles will be extracted by means of a standardized form and the results presented in a flowchart and narrative summary.

**Final Considerations:** once carried out, this protocol will present the state-of-the-art on the research topic and help better understand the possibilities to quantitatively analyze swallowing through ultrasound.

**Keywords:** Swallowing; Swallowing Disorders; Biomechanical Phenomena; Ultrasonography

Received on: August 6, 2022

Accepted on: October 27, 2022

**Corresponding address:**

Leandro Pernambuco  
Departamento de Fonoaudiologia  
Universidade Federal da Paraíba  
Jardim Cidade Universitária, S/N,  
Castelo Branco, João Pessoa, Paraíba,  
58051-900, Brasil.  
E-mail: leandropernambuco@gmail.com

## INTRODUCTION

Biomechanical swallowing phenomena can be analyzed with various technological imaging resources, such as fiberoptic endoscopic evaluation of swallowing (FEES), videofluoroscopic swallowing study (VFSS), and ultrasound (US)<sup>1,2</sup>. FEES is an endoscopic examination with visual-perceptual analysis that enables laryngopharyngeal observation and laryngeal sensitivity assessment; moreover, it is quick and does not expose the patient to radiation<sup>3,4</sup>. VFSS enables the dynamic analysis of all swallowing phases to detect functional changes<sup>5,6</sup>; however, it exposes patients to low ionizing radiation doses, uses barium sulfate, and it is more expensive and less accessible<sup>7-9</sup>.

On the other hand, US is an instrumental resource that makes static and dynamic images of human body structures in real-time through high-frequency acoustic echoes, which are sent from a movable transducer to be electronically decoded for immediate or later analyses<sup>10,11</sup>. This noninvasive method does not use either contrast agents or radiation and is performed with portable equipment available in health services<sup>7,12</sup>.

US has been used to investigate swallowing in the oropharynx of individuals with and without disorders to assess the muscle morphometry and kinematics of the function, observe qualitative and quantitative measures, and complement the diagnosis of dysphagia<sup>1,7,8,11-14</sup>. Despite such benefits, US has still been little explored in clinical practice due to little reliance on data acquisition and image selection for interpretation and the lack of consensus on assessment parameters. Hence, it is necessary to develop methodological protocols and standardize kinematic measures of swallowing to precisely assess the function with US.

Thus, this study aimed to identify and synthesize scientific evidence on kinematic measures of swallowing obtained with US. The resulting data are expected to establish which measures can be obtained with US and how these measures can help diagnose and monitor swallowing mechanisms.

## METHODS

This protocol followed the method proposed by the Joanna Briggs Institute (JBI)<sup>15</sup> and the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P)<sup>16</sup>. Since PRISMA-P is made for systematic reviews, only the

items on scoping reviews were considered, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols - extension for scoping reviews (PRISMA-ScR)<sup>17</sup>. The protocol for this review was registered in Open Science Framework (<https://osf.io/2aeg3/>). Possible methodological changes throughout the development of the study will be reported in the scoping review.

The research question was constructed based on the PCC acronym (population, concept, and context): **a) regarding population:** young and older adults with and without dysphagia; **b) regarding concept:** kinematic measures of swallowing; **c) regarding context:** studies analyzing kinematic measures of swallowing obtained with US.

The following scoping review research question was defined based on these definitions: "Which kinematic measures of swallowing can be obtained with US in young and older adults with or without dysphagia?"

## Eligibility criteria

The study inclusion criteria were defined according to the PCC acronym – i.e., studies analyzing one or more kinematic measures of swallowing (e.g., amplitude, time, velocity) obtained with US in young or older human adults with or without dysphagia, regardless of underlying diseases. Articles published in peer-reviewed journals, textbooks, editorials, conference proceedings, and dissertations/theses will be considered, with no restriction on language or date of publication. The exclusion criteria were as follows: studies unavailable in full text, whose sample comprised only children, focused only on morphometric measures or descriptive analysis or approaching measures obtained with US only to analyze other functions.

## Search strategy and sources of information

The search terms were initially selected based on the research question and validated in Medical Subject Headings (MeSH), which collects terms in English for search in databases. Thus, the words in the titles, abstracts, and keywords in relevant articles on the topic were used to develop a search strategy for PubMed/MEDLINE (Chart 1), which will be adapted for each database, namely: PubMed/MEDLINE, Scopus, Web of Science, LILACS, ScienceDirect, and Embase. Google Scholar was chosen for search in the grey literature.

## Study selection and extraction

After identified in the databases, the articles will be imported to EndNote reference management software (Clarivate Analytics, PA, USA), which will identify and

exclude duplicates. Relevant studies to the scope will be imported to Rayyan software (Qatar Computing Research Institute, Doha, Qatar), which blinds collaborating reviewers and improves data screening.

**Chart 1.** Search strategy – PubMed/MEDLINE (search made on July 27, 2022).

Search	Keywords	Records found
#1	(((((deglutition disorders[MeSH Terms]) OR (dysphagia[MeSH Terms])) OR (swallowing disorders[MeSH Terms])) OR (deglutition[MeSH Terms])) OR (swallowing[MeSH Terms])) OR (dysphagia)) OR (deglutit*) OR (swallow*)	101,322 results
#2	(ultras*)	1,152,372 results
#3	((((measure*) OR (quantitative evaluation[MeSH Terms])) OR (kinematics[MeSH Terms])) OR (kinemat*))	4,895,840 results
#4	#1 AND #2 AND #3	479 results

Two independent reviewers will classify each article by title and abstract for inclusion or exclusion. After this phase, all articles included will be assessed by full-text reading, considering the eligibility criteria. If reviewers diverge on article selection, they will discuss and solve the issues. If they cannot be solved by consensus, a third reviewer will join them.

Data will be analyzed to meet the study objectives, and research results will be presented in a flowchart

according to the PRISMA extension for scoping reviews (PRISMA-ScR)<sup>16</sup> and published along with the scoping review.

The synthesis of the review will present the main information extracted from included articles, using an instrument developed by the reviewers (Chart 2). They will be independently extracted by two calibrated reviewers, and data will be synthesized in a single version based on consensus.

**Chart 2.** Data extraction instrument

Article identification:	
Author(s):	
Year of publication:	
Country of origin:	
Institution(s) where the study was conducted:	
Population:	
Objective:	
Kinematic measure(s):	
Acquisition and analysis method:	
Main results:	

## Outcomes

The study will collect variables on article characteristics (year of publication and country of origin), study participants' profiles (sex, age, and clinical aspects, such as underlying disease and dysphagia), and data on the measures (description of kinematic measures of swallowing and method to acquire and analyze them). The tool developed to extract data may be reviewed and modified as needed; such changes will be detailed in the scoping review.

## Data synthesis

Data will be analyzed according to the research objectives, describing researched variables and study methodologies in all articles included in the review. To meet its objectives, this scoping review will:

1. Identify which kinematic measures of swallowing are obtained with US.
2. Verify what methods were used to acquire and analyze the measures (protocol or scale standardization).
3. Explore the content of these studies (indication criteria, analysis method, and results).

The analysis will encompass qualitative and quantitative methods. Extracted data will be presented in a flowchart, and mapped results will be described in the discussion to reach the review objectives, answer the research question, and point out gaps in the topic.

## DISCUSSION

US is a technological imaging resource for the analysis of muscle morphometry and kinematics of swallowing in individuals with and without disorders<sup>1,7,8,10-14</sup>. Concerning the kinematics of swallowing, various US parameters are considered; the most evident findings are related to hyoid bone elevation and tongue movements<sup>18</sup>.

In swallowing, the hyoid bone is displaced in a superior-anterior movement that helps relax the pharyngo-esophageal segment and activate airway protection mechanisms<sup>2,10</sup>. Therefore, it is an important aspect to assess the safety and efficiency of swallowing<sup>10,11</sup>, and it can be rather reliably analyzed with US<sup>9,10</sup>.

Furthermore, US can measure tongue mobility properties during swallowing<sup>1,12,18,19</sup> - e.g., by observing the movement pattern and duration of tongue propulsion when swallowing<sup>14,20</sup>.

Hence, mapping scientific evidence on the topic researched with this scoping review will provide an

overview of the literature and identify the need for systematic reviews or primary research. This protocol was developed according to the guidelines proposed by the Joanna Briggs Institute (JBI) for scoping reviews.

## FINAL CONSIDERATIONS

Once carried out, this protocol will present the overall state of the literature on the topic and identify existing gaps. The previous publicization of this scoping review protocol will help plan and develop assessment standardization methods, which will be useful to both clinical practitioners and scholars.

## REFERENCES

1. Allen JE, Clunie GM, Slinger C, Haines J, Mossey-Gaston C, Zaga CJ et al. Utility of ultrasound in the assessment of swallowing and laryngeal function: a rapid review and critical appraisal of the literature. *International Journal of Language and Communication Disorders*. 2021;56(1):174-204.
2. Lynch CS. Análise da fisiologia da deglutição por meio da ultrassonografia [thesis]. São Paulo (SP): Faculdade de Medicina da Universidade de São Paulo; 2008.
3. Langmore SE. History of fiberoptic endoscopic evaluation of swallowing for evaluation and management of pharyngeal dysphagia: changes over the years. *Dysphagia*. 2017;32(1):27-38.
4. Souza GAD. Confiabilidade inter e intra-juízes da Escala de Classificação para Escape Oral Posterior na Videoendoscopia de Deglutição [Dissertation]. Marília (SP): Universidade Estadual Paulista - Unesp; 2021.
5. Nam HS, Oh BM, Han TR. Temporal characteristics of hyolaryngeal structural movements in normal swallowing. *Laryngoscope*. 2015;125(9):2129-33.
6. Kraaijenga SA, Van der Molen L, Heemsbergen WD, Remmerswaal GB, Hilgers FJM, Van den Brekel MWM. Hyoid bone displacement as parameter for swallowing impairment in patients treated for advanced head and neck cancer. *Eur Arch Otorhinolaryngol*. 2017;274(2):597-606.
7. Feng X, Cartwright MS, Walker FO, Bargoil JH, Hu Y, Butler SG. Ultrasonographic evaluation of geniohyoid muscle and hyoid bone during swallowing in young adults. *Laryngoscope*. 2015;125(8):1886-91.

8. Lee YS, Lee KE, Kang Y, Yi TI, Kim JS. Usefulness of submental ultrasonographic evaluation for dysphagia patients. *Ann Rehabil Med.* 2016;40(2):197-205.
9. Chen YC, Hsiao MY, Wang YC, Fu CP, Wang TG. Reliability of ultrasonography in evaluating hyoid bone movement. *J Med Ultrasound.* 2017;25(2):90-5.
10. Andrade RA, Sales Coriolano MGW, Souza ELH, Silva JHC, Cunha MD, Pernambuco L et al. Reliability of ultrasound examination of hyoid bone displacement amplitude: a systematic review and meta-analysis. *Dysphagia.* 2022 ahead of print.
11. Allen JE, Clunie GM, Winiker K. Ultrasound: an emerging modality for the dysphagia assessment toolkit? *Curr Opin Otolaryngol Head Neck Surg.* 2021;29(3):213-8.
12. Allen JE, Clunie G, Ma JKY, Coffey M, Winiker K, Richmond S et al. Translating ultrasound into clinical practice for the assessment of swallowing and laryngeal function: a speech and language pathology-led consensus study. *Dysphagia.* 2022;37(6):1586-98.
13. Oh EH, Seo JS, Kang HJ. Assessment of oropharyngeal dysphagia in patients with Parkinson disease: use of ultrasonography. *Ann Rehabil Med.* 2016;40(2):190-6.
14. Galli SM, Silva RG, Berti LC. Qualitative and quantitative ultrasound analysis of oropharyngeal swallowing. *CODAS.* 2015;27(5):437-45.
15. Peters MDJ, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. *Int J Evid Based Healthc.* 2015;13(3):141-6.
16. Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M et al. The PRISMA-P Group. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ.* 2015.349:g7647.
17. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med.* 2018;169(7):467-73.
18. Leite KKA, Mangilli LD, Sassi FC, Limongi SCO, Andrade CRF. Ultrasonography and swallowing: a critical review of the literature. *Audiol., Commun. Res.* 2014;19(4):412-20.
19. Li C, Li J, Zhang C, Cao X, Li N, Song D et al. Application of B+M-mode ultrasonography in assessing deglutitive tongue movements in healthy adults. *Med Sci Monit.* 2015;21:1648-55.
20. Peng CL, Miethke RR, Pong SJ, Lin CT. Investigation of tongue movements during swallowing with M-mode ultrasonography. *J Orofac Orthop.* 2007;68(1):17-25.