

(1) Swallowing and Salivary Bioscience Lab, Geriatric Research Education and Clinical Center (GRECC), William S. Middleton Memorial Veterans Hospital (2) Department of Rehabilitation Sciences, Universidad del Bío-Bío (Chile) (3) Department of Communication Sciences and Disorders, University of Wisconsin-Madison (4) Department of Surgery-Otolaryngology, University of Wisconsin-Madison (5) Ebling Library, Health Sciences Learning Center, School of Medicine and Public Health, University of Wisconsin-Madison (6) Geriatric Research Education and Clinical Center (GRECC), William S. Middleton Memorial Veterans Hospital

### BACKGROUND

- Dysphagia is a swallowing disorder that involves impairment of both sensory and motor responses. Sensory function has shown to play an important role in modulating swallowing physiology
- Sensory properties of food are characteristics detected by the organs of senses and they provide sensory input that can modify swallowing physiology.
- Three reviews have been conducted to pool the evidence regarding the relationships among sensory properties of food and swallowing. However, they have not included all properties of food/liquids nor use of the Cochrane systematic review methodology

### PURPOSE

- To perform a systematic review to understand which specific properties of food and liquids are associated with changes in swallowing physiology in adults with and without dysphagia.
- To provide a comprehensive qualitative analysis of the evidence published in the literature to date.

### METHODS

We followed the methodology of the Cochrane Handbook for Systematic Reviews of Intervention.

**1 Development of the review protocol**

**2 PICO Question**

**P** Healthy adults and patients with dysphagia

**I** Any modified food and/or liquid

**C** Not included

**O** Any measurement pertaining to swallowing physiology

Can sensory properties of foods and liquids improve the swallowing physiology in healthy adults and patients with dysphagia?

**3 Search Strategy**

- English, Spanish, and Japanese Languages.
- 3 types of search:
  - 1. *Online in 8 databases*  
PubMed, CINHAL, Scopus, Web of Science, Cochrane Library, PsychINFO, Food Science and Technology Abstract, and Chemical Abstracts
  - 2. *Online in 2 journals*  
Chemical Senses, Journal of Texture Studies
  - 3. *Review of reference list of included studies*
- Keywords selected for Population, Intervention, and Outcome

**4 Data Collection**

**1. Study Selection**

Use of inclusion/exclusion criteria	Title/abstract screening using software <b>covidence</b>	Full-text retrieval/reading for final selection	Consensus meetings for final decision
-------------------------------------	---	---	---------------------------------------

**2. Data Extraction**

- Extraction of data from selected studies
- Consensus meetings to solve disagreements on data extraction.

**5 Risk of Bias Assessment**

- RoB-2 : Randomized Clinical Trials
- ROBINS-I : Non-Randomized Studies

### RESULTS

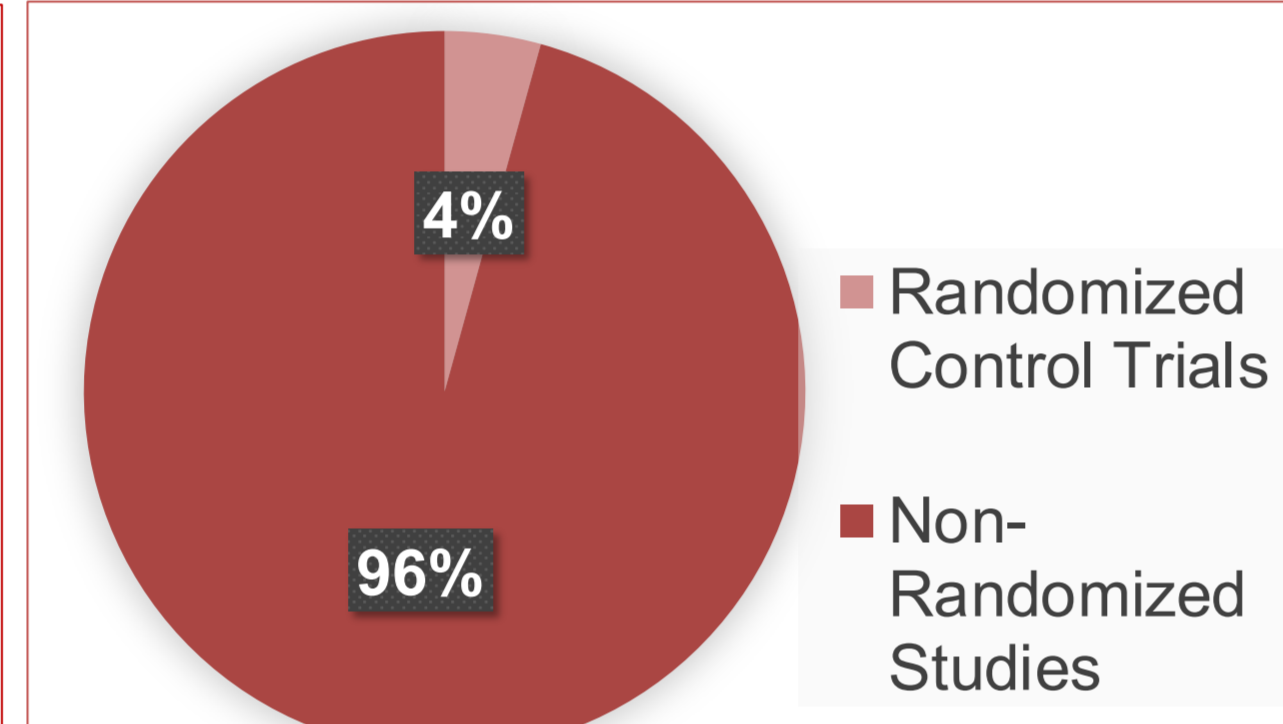
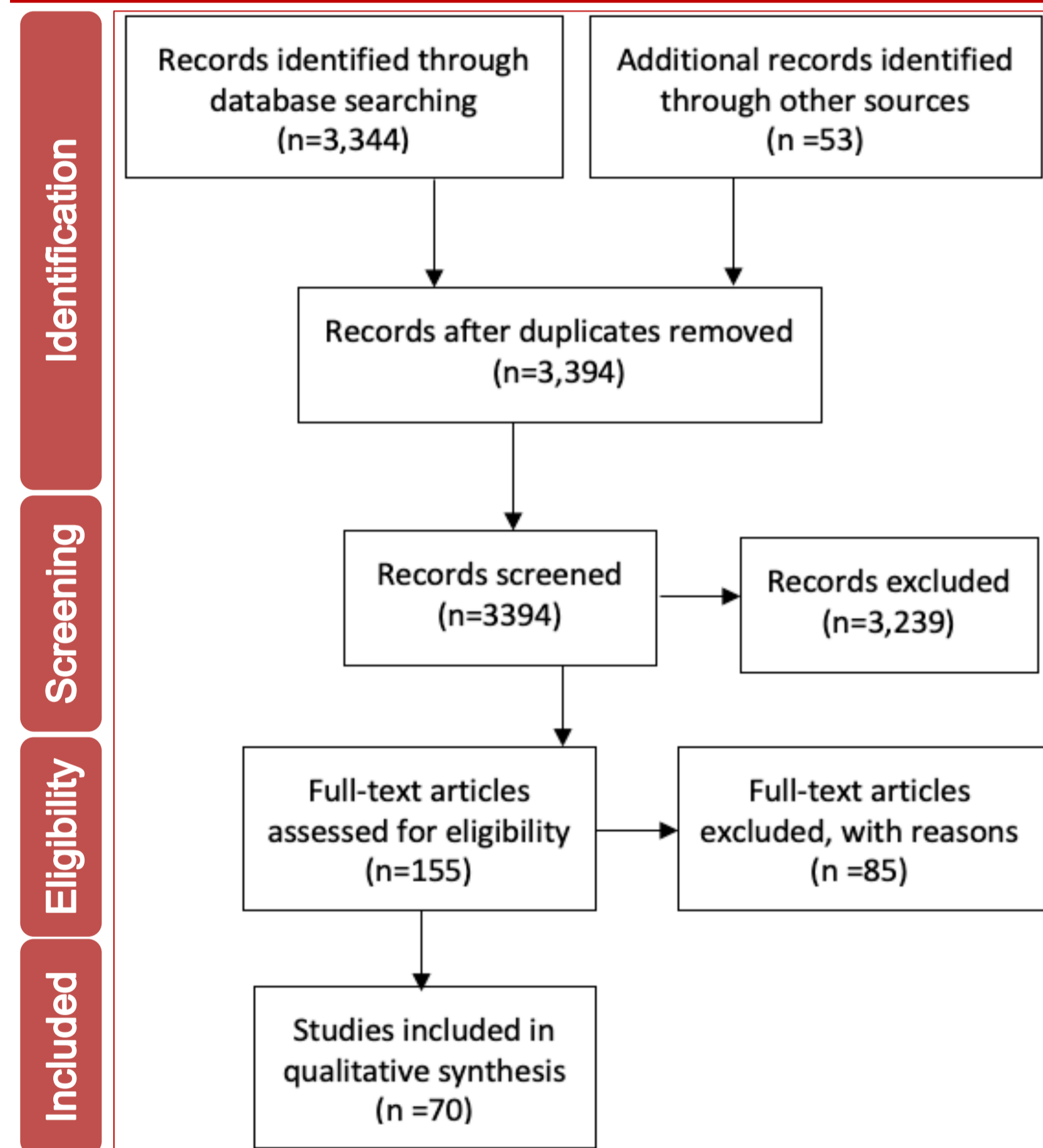


Figure 2. Study design of selected studies (n=70)

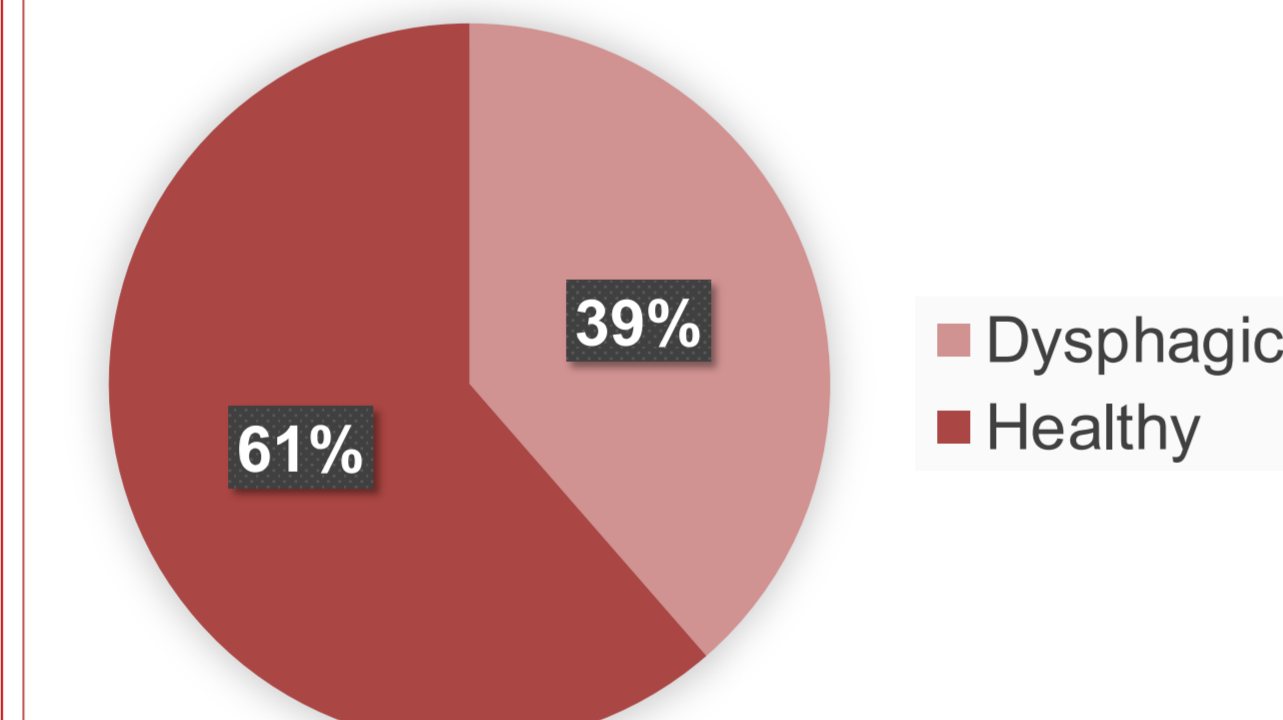


Figure 3. Included studies by population (n=70)

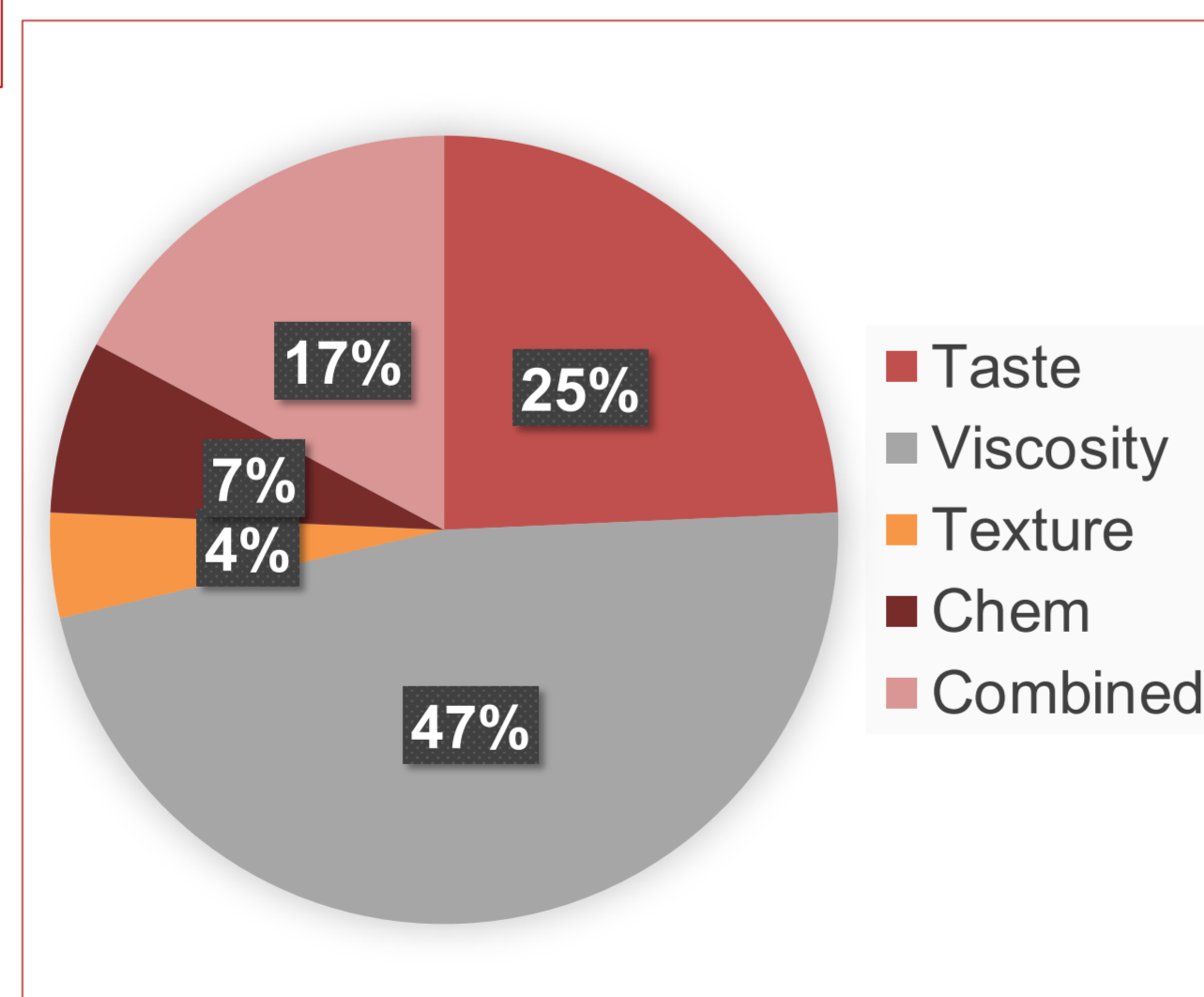


Figure 4. Properties of food/liquids assessed in selected studies (n=70)

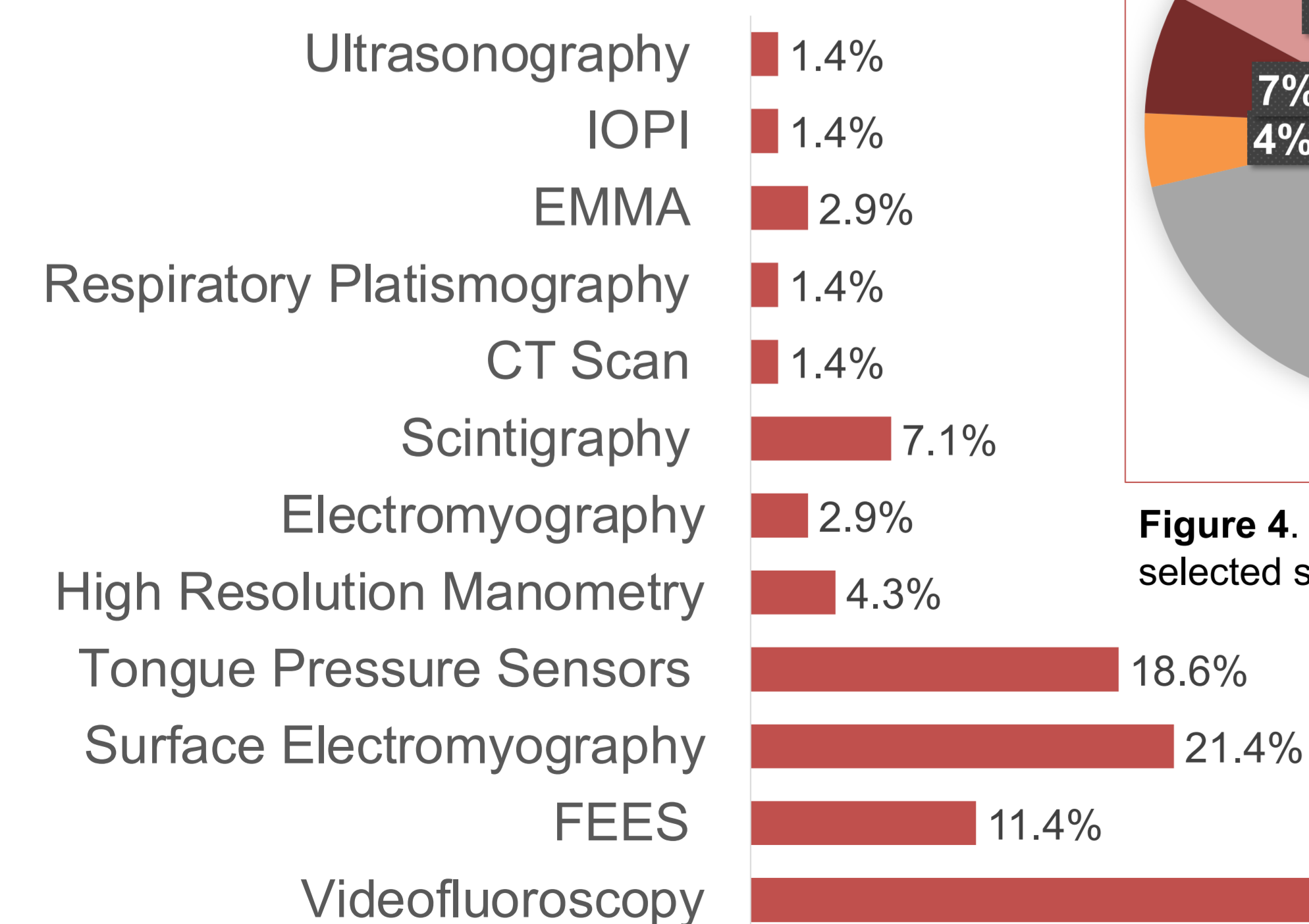


Figure 5. Instrumental procedures used in selected studies.

IOPI (Iowa Oral Performance Instrument)  
EMMA (Electromagnetic midsagittal articulography)  
FEES (Fiberoptic Endoscopic Evaluation of Swallowing)

Table 1. Main swallowing related areas influenced by viscosity, taste and chemesthesis in healthy participants.

Swallowing Area	SENSORY PROPERTY			Effect	Risk of Bias Assessment
	Viscosity	Taste	Chemesthesis		
Tongue	Not found	Sour, Barium + Sour, Sweet, Salty	Not found	↑ Lingual swallowing pressure	Pelletier and Dhanaraj et al., 2006
	Not found	Not found	Flavored water with gas volume 0	↑ Duration of linguopalatal swallowing pressure	Morikata et al., 2014
Pharynx	Nectar, Pudding	Not found	Not found	↑ Lower pharyngeal peak pressure	Butler et al., 2009
Larynx	Not found	Not found	Carbonated beverage	↓ Duration of laryngeal elevation	Morishita et al., 2014
	Spoon-thick viscosity	Not found	Not found	↓ Laryngeal Vestibular Closure	Rofes et al., 2014
Upper Esophageal Sphincter	Spoon-thick viscosity	Not found	Not found	↓ UES opening	Rofes et al., 2014
Swallowing Residue	Nectar, Pudding	Not found	Not found	↓ UES relaxation pressure	Butler et al., 2009
	Thick viscosity	Not found	Not found	↑ Pharyngeal residue	Hamlet et al., 1996

Moderate risk of bias; Serious risk of bias.

Table 2. Main swallowing related areas influenced by viscosity and taste in patients with dysphagia.

Swallowing Area	SENSORY PROPERTY		Effect	Risk of Bias Assessment
	Viscosity	Taste		
Tongue	Not found	Barium+Sour, Barium+Sweet+Sour	↑ Tongue base retraction	Dietch et al., 2019
	Not found	Barium+Sour	↑ Onset tongue base motion toward the posterior pharyngeal wall	Logemann et al., 1995
Pharynx	Not found	Barium+Sour, Barium+Sweet	↓ Pharyngeal Transit Time	Cola et al., 2010 <sup>**</sup> ; Logemann et al., 1995
	Not found	Barium+Sour	↑ Pharyngeal response time	Logemann et al., 1995
Larynx	Not found	Barium+Sour, Barium+Sweet+ Sour	↑ Hyolaryngeal displacement	Dietsch et al., 2019
	150- 2000 mPa s	Not found	↓ Laryngeal Vestibular Closure	Bolivar-Prados et al., 2019
Upper Esophageal Sphincter	Not found	Barium+Sour, Barium+Sweet+Sour	↓ UES opening	Logemann et al., 1995; Dietsch et al., 2019
	Thick bolus (>1750 cP)	Not found	↑ UES opening	Lee et al., 2013, Rofes et al., 2014
Swallowing Outcome: Aspiration	Nectar, Honey, Pudding	Sour	↓ Aspiration	Pelletier & Lawless, 2003, Clave et al., 2006, Leder et al., 2013, Leonard et al., 2014

Moderate risk of bias; Serious risk of bias; Critical risk of bias

### DISCUSSION

- Sensory properties of food and liquids (SPF/L) showed to modify several swallowing structures and outcomes in both healthy participants and patients with dysphagia.
- The review found ample variability in swallowing related outcomes, and instrumental assessment of the swallowing.
- The assessment of risk of bias found that, in general, most of the studies are at serious risk of bias. Future studies might consider a careful study design when assessing the relationship between swallowing and food and liquids.

### CONCLUSION

- Variations in the viscosity, taste, texture, and chemesthetic properties of solids and liquids were found to modify swallowing physiology in both healthy adults and patients with dysphagia.
- These data will be critical as a foundation for scientists and clinicians to collaboratively develop beverages and foods that optimize swallowing function for patients with dysphagia.

### ACKNOWLEDGEMENTS

Wisconsin Alzheimer's Disease Research Center P30-AG062715. Fulbright fellowship for the first author and ANID BECAS/DOCTORADO EXTRANJERO/56150014