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A systematic review of the factors affecting textural perception by older adults and their association with food choice and intake

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ABSTRACT

Eating behaviours among older adults can be affected by age-associated oral physiological changes. This may influence nutritional intake, liking and acceptance of foods, increasing malnutrition risk. To better understand age-associated changes to textural perception, a systematic review was designed to evaluate the factors that affect the perception of food texture among older adults, and the impact this has on food liking and intake. Electronic searches were conducted in three databases (Pubmed, WebofScience, Scopus), yielding 12,216 articles. The 2020 PRISMA guidelines were used to screen all articles; these were assessed in three stages, by title, abstract and full text. Subsequently, PECO (population, exposure, comparison, outcome) guidelines were applied to assess study eligibility. 13 articles were included in the final review, all of which were of sufficient quality. A wide range of methodologies and outcomes were identified, leading to the discussion of findings in three categories; (i) oral manipulation and processing of food types within the oral cavity, (ii) age-associated changes to the physical properties of this cavity, and (iii) psychological factors that influence food choice and acceptance. A combination of these factors facilitate textural manipulation and perception in older adults, which were shown to significantly drive product acceptance and intake. Whereas several perceptual and physiological changes that occur with aging are unavoidable, recognising the heterogenous nature of older adults will lead to a better understanding of the oral capabilities and sensory-specific needs of this population, and could be used to improve food acceptance, nutritional intake and reduce the risk of malnutrition.

1. Introduction

1.1. Ageing population and age associated physiological changes

People worldwide are living longer, resulting in an increase in both the number and proportion of older people in the population (World Health Organisation, 2024). Specifically, in England and Wales, 'Census 2021' results reported that over 11 million people, which is 18.6 % of the total population, were aged 65 years or older in 2021, compared with 16.4 % in the 2011 report (Office for National Statistics, 2022). Ageing is related to physiological changes, either as part of the normal ageing process or as a consequence of disease, multimorbidity, frailty or a combination of these factors (Preston & Biddell, 2021). Physiological changes occur throughout the entire gastrointestinal system, including the mouth, upper and lower gastrointestinal tract (Preston & Biddell, 2021). Age-associated changes to the oral cavity include tooth loss,

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xerostomia, dysphagia, reduced strength of mastication muscles, delayed gastric emptying, and increased intestinal transit time can lead to reduced food intake, early satiety, impaired appetite and combine to produce poor nutritional patterns (Narhi et al., 1999; Ganbavale et al., 2025). One response to these changes has been to alter the textures and consistencies of the foods consumed within this population.

1.2. Need for design of food products for older adults

In response to the increase in prevalence of these age-associated changes across the population, there is a growing need to design texture-appropriate food products for this demographic. Food texture modification has been studied in younger adults and has been shown to affect oral processing and food intake (Bolhuis & Forde, 2020); increased lubrication and decreased elasticity/chewiness can increase eating rate and food intake (Bolhuis & Forde, 2020), while harder textures require increased oral processing and decrease food intake (Wallace et al., 2023). The development of food products may address the specific sensory and dietary needs of different subgroups of older adults, ranging from energy requirements, and macro- and micro-nutrient fortification, to modification of food texture (Qin et al., 2024). Textural modification of foods, which is the focus of this systematic review, has been suggested for people with dysphagia, other swallowing problems and/or dental issues to prevent choking (Cichero, 2016; de Sire et al., 2022), but also for those with tooth loss and reduction in masticatory muscle mass in order to make the eating process less tiring (Peyron et al., 2017). Consuming softer foods causes less chewing-related fatigue and prevents harm to the oral mucosa and oesophagus (Cichero, 2016). In addition, pureed foods and thickened liquids pose lower aspiration risk and are less likely to cause choking than regular meals and thin liquids respectively (Makame, Nolden and Emmambux, 2023). The moisture content of food is also important: soft and high-moisture foods such as purees and custards are often suggested to be more suitable for the older population, as they require less salivary interaction while chewing and shorter chewing times to moisten the bolus before swallowing (Cichero, 2016; Xu et al., 2019). However, higher moisture content can result in lower energy densities, meaning that often these foods have to be consumed in larger amounts to deliver the same nutritional benefit (Rolls, 2006).

1.3. Sensory perception by older adults

When exploring the factors that affect sensory perception by older adults, research has largely focused on the perception of taste and smell, due to age-related changes to the olfactory and gustatory systems. There is limited literature describing how ageing affects the perception of food texture. However, factors like poor chewing ability, difficulty in swallowing and the fear of choking seem to affect older adults' perception of food's textural properties and consequently affect their food intake (Vandenberghe-Descamps et al., 2017; Namasivayam-MacDonald et al., 2017). Manipulating the texture of familiar foods to enable their oral processing can influence their sensory perception, and significantly reduce their sensory appeal (Forde & de Graaf, 2022). This is further complicated by the heterogeneity of the older adult population (Ferrucci & Kuchel, 2021), where there may be a wide diversity in residual perceptual and oral processing abilities and differences in nutrient needs and prevalence of chronic conditions. Thus, there is a need to explore these factors in a systematic way to better understand the mechanisms that influence textural perception in this demographic.

1.4. Aims & objectives

The primary aim of this systematic review was to explore the factors that affect the textural perception of foods and drinks by older adults (65+) and how these influence liking and consumption. This was addressed using the PECO guidelines (Table 1) (Morgan et al., 2018).

Table 1
PECO guidelines and their application in this systematic review.

Category	Description
Population	Older adults (65+) without regard to sex, race, ethnicity or care settings (hospitalised, institutionalised, community dwelling)
Exposure	Different food and drink textures
Comparison	Individual differences in textural perception based on specific characteristics (including salivary flow, dentition, oral processing)
Outcome	Liking/appeal, sensory perception and consumption

Additionally, a secondary research aim was introduced to comprehensively summarise the literature, as some studies exploring textural perception did not investigate the subsequent effect on food liking or consumption. Thus, the secondary aim was to further explore age-associated factors influencing textural perception of foods, where links to liking and consumption were outside of the scope of the research papers. This was investigated using the population, exposure and comparison categories of the PECO guidelines (Table 1) without a known specific outcome. The results associated with the secondary aim were presented as a separate results table.

2. Methodology

A comprehensive literature review was conducted using three online databases (PubMed, Web of Science, Scopus). The searches were conducted on May 14, 2024. Only original peer-reviewed human studies published in the last 20 years in English were included, upon which the inclusion/exclusion criteria were applied (Table 2). A broad range of search terms were used for texture and age to increase the likelihood of identifying all relevant literature addressing the research question (Table 3). Additional search terms of saliva/xerostomia/dry mouth/dentition/dentures were added in a final separate search string (Supplementary Tables 1–3) to ensure that all parameters were captured. Search strings are provided in Supplementary Table 1. The search terms were developed by the two primary researchers (DZ and HG) and validated by an independent researcher (MC). Boolean search strings were used to increase the relevance and suitability of search results, with modifications made as appropriate for the search engine. The article lists generated by the databases were exported to Microsoft Excel.

This search strategy identified a total of 12,216 articles, after the removal of 16,915 duplicates. Initially articles were screened based on their title by two independent researchers (DZ and HG): articles selected for inclusion by either or both researchers were taken forward for abstract screening (n = 315). The abstract-selected articles were assessed based on their full text for eligibility using the study's PECO guidelines. Furthermore, the search strings identified 70 relevant review papers. The reference lists of these were examined; the researchers identified seven additional articles which were then screened using the above eligibility process. This resulted in one additional research paper being included. Overall, final list of articles that aligned with the study's primary and secondary objectives were established (n = 6 and n = 7, respectively).

The 2020 PRISMA guidelines were used to report the methodology of this systematic review (Fig. 1). The quality of all papers included was assessed using the National Institute of Health's Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (National Institute of Health, 2021) (Supplementary Table 4). The 2020 PRISMA checklist was used to increase the reliability of the manuscript (Supplementary Table 5) and abstract (Supplementary Table 6).

Key information was extracted from the final 13 articles by two researchers (DZ and HG), for participant information (age, sex, number of participants and participant details), study design, method of modification/manipulation, measurements and outcomes. To synthesise the output from the extracted information the lead authors (DZ, HG) first

Table 2
Inclusion and exclusion criteria used for the search strategy.

Inclusion criteria
Peer reviewed
Relevant to research question (different food and drinks textures, individual differences in textural perception based on specific characteristics, liking/appeal/sensory perception/ consumption)
Age range defined (65+) for all sample or for an isolated older adult group (65+)
Oral feeding method
Community/hospital/care setting
Exclusion criteria
Not in English
Full text not available
Published before 2004 [more than 20 years ago]

Table 3
Search terms used in all search engines. Asterisk was used to detect truncation of similar words with different endings.

Texture
Oral processing/manipulation/ability*
Chewing
Mastication
Eating capacity*/capability*
Mouthfeel
Textural perception
Food texture
Food perception
Food structure
Food surface
Food particles
Age
Older adult/person/people/population/patient*/individual*
Elder*
Ageing
Aging
Senior*
Geriatric
Senescent*
65 years
Retired

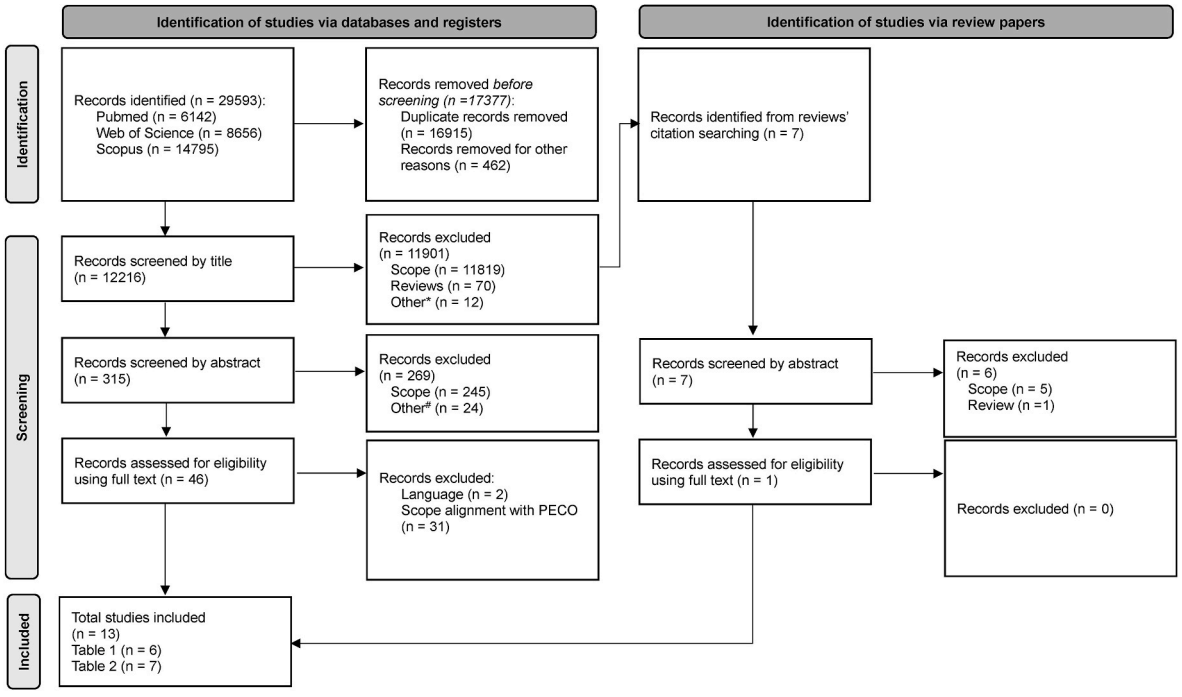

Fig. 1. PRISMA (2020) flow chart of literature search strategy, screening, and exclusion criteria.

identified commonalities and differences between the outcomes of the 13 articles. Secondly, four authors (DZ, HG, MC, LM) discussed together the emerging themes which led to the development of three output categories: (i) oral manipulation and processing, (ii) physical characteristics of the oral cavity, and (iii) individual food preferences and acceptance.

3. Results

3.1. Primary research aim

The search strategy identified six articles that were closely aligned with the primary research aim, to investigate factors affecting textural perception and the subsequent effect on liking and consumption as concluded from the PECO assessment. These articles are summarised in Table 4. A wide age-range was covered by these studies (68–99 years), with studies varying in mean age and age range (as shown by the differences in standard deviation). Five of the six studies included both males and females, with the exception of Leiberg et al. (2002) which only studied males. This international review included papers from Japan (n = 2), Sweden (n = 2), Italy (n = 1), and Spain and the UK combined (n = 1). Due the geographical differences a range of food types were used in these studies: some compared individual foods with different textures, whereas others created a full modified diet, such as through the use of heat and enzymes to soften foods (Higashiguchi et al., 2017). Studies included participants from a range of settings including community dwelling, nursing homes, special housing, and hospitals: a combination of these settings was also compared in some of the studies (Laguna et al., 2016; Rothenberg et al., 2007). Several of the studies used a combination of sensory evaluation and self-reported questionnaires to record opinions on perception, acceptance and liking of attributes (Higashiguchi et al., 2017; Kamei et al., 2024). Several measurements of oral processing and eating capability were investigated (Rothenberg et al., 2007; Laguna et al., 2016). Physiochemical characteristics of foods were also measured (Crippa et al., 2003). The key participant details, study information and outcomes of these papers (n = 6) are summarised in Table 4.

3.2. Secondary research aim

The search strategy identified a further seven articles that aligned with the secondary research aim, investigating factors affecting textural perception without a specific outcome with regards to liking and consumption. These articles were incorporated in the review as a separate table (Table 5). Mean ages ranged from 70 to 87 for these studies and both males and females were included. The studies included participants from Japan (n = 3), Sweden (n = 1), France (n = 1), and Korea (n = 2). Participants were recruited from a range of settings, including community-dwelling, long- and short-term care institutions, and nursing homes. The key participants details, study information and outcomes of these studies (n = 7) were summarised in Table 5: these include oral examinations (Kikuchi et al., 2021; Kim & Lee, 2021; Stenman et al., 2012), measurements of physical ability (Kito et al., 2019; Yamada et al., 2017; Park et al., 2017), and limited data on food liking and intake (Geny et al., 2024).

4. Discussion

This systematic review explored factors affecting the textural perception of foods by older adults and the subsequent association with liking and consumption. This was achieved via the assessment of 13 articles which were identified through the systematic screening of three databases, following the PRISMA guidelines (Fig. 1) and screened for quality assessment (Supplementary Table 4). All studies were shown to be of acceptable quality with most of the criteria being met (National Institute of Health, 2021). Using the PECO guidelines, two study aims were identified and the associated papers for each were presented separately (Tables 4 and 5, respectively). A wide range of methodologies and outcomes were identified. Consequently, three categories of the factors that influence textural perception by older adults were established, as follows: oral manipulation and processing of food types within the oral cavity; the physical characteristics of this cavity; and the individual factors that influence food preference and acceptance. The discussion of results has been divided into these categories to address the individual factors from the viewpoint of mouth behaviour, anatomy, and psychology, which all combine to facilitate textural perception.

4.1. Oral manipulation and processing

Oral processing can be influenced by both population and food-specific characteristics. Studies that have explored textural perception by different age-groups have reported differences in mastication and swallowing: older adults showed a significantly higher number of chews than younger adults in all harder samples of a rice food product (Park et al. (2017), while they also presented with dysfunctional swallowing which can increase eating duration and prolong mastication. It has also been observed that older adults living in special housing (i.e., assisted living), who were found to be in poorer health status than those in ordinary housing, experienced more impaired swallowing and reported that they found texture modified versions of food products were easier to masticate and swallow (Rothenberg et al., 2007). Swallowing and breathing-swallowing coordination in older adults is affected by differences in the viscosity of foods (Higashiguchi et al., 2017).

Textural manipulations of foods were shown to affect textural perception and food intake. When comparing protein-fortified foods with unfortified versions of the same foods, fortified foods were perceived as more difficult to chew, moisten and swallow (Geny et al., 2014). Higashiguchi et al. (2017) also showed that textural manipulation influences textural perception. Here the authors compared a texture-modified diet produced using enzymes to resemble ordinary meals, with a traditional texture-modified diet. Both diets had comparable levels of satisfaction with equivalent ratings for ease of eating, swallowing and softness, however, the diet that resembled ordinary meals scored higher in satisfaction with appearance, though there was no associated increase in food intake (Higashiguchi et al. 2017).

The association between the duration of food oral processing with perceived texture has also been explored. Kamei et al. (2024) found an association between eating time and texture preference, but not between eating time and perceived textures, such as smoothness. The “high smoothness preference group” (i.e. a group that perceived smoothness more intensely in a previous study by the same authors) showed significantly longer eating time by 16.7 % when compared with the “low smoothness preference group” (Kamei et al. 2024). The authors explained that the “high smoothness preference group” were more likely to use oral processing involving the tongue and palate rather than the teeth to perceive smoothness more intensely. The authors concluded that eating time may be influenced by oral manipulation patterns but cannot solely explain individual differences in texture perception and, therefore, eating time was categorised as a secondary parameter associated with texture perception. This could support a bi-directional relationship where oral manipulation patterns influence preferred eating time and in turn drive differences in texture perception. In addition, Laguna et al. (2016) showed that longer oral residence time is related to greater chewing effort in older adults. This highlights the impact of oral processing behaviours on textural perception. This can assist in the development of foods for older adults who are likely to manipulate food differently from the general population as a result of changes within the oral cavity.

4.2. Physical characteristics of the oral cavity

The physical properties of the oral cavity display age-associated

Table 4
A summary of original studies that have addressed the factors influencing textural perception by older adults, and the subsequent impact on liking and acceptance. These studies answer the primary research aim (to investigate factors affecting textural perception and the subsequent effect on liking and consumption) and address all four PECO parameters.

Reference	Participant information				Study information			Outcomes
	Age	S	N	Participant details	Study design	Type of modification/ manipulation	Measurements	
Crippa et al. (2023)	Standard Diet: 82.2 (SD 9.8). Modified Diet: 81.5 (SD 11.6)	Mixed	86	Hospitalised patients in Italy, prescribed homogenized diet, BMI Standard Diet: 22.2 (SD 3.5). Modified Diet: 23.4 (SD 5.4). Average number of teeth not reported.	Retrospective and observational design.	Standard Diet versus Modified Diet with differences in presentation, preservation, structure and composition	Food intake, food waste, rheological characteristics, and palatability	* Modified diet has a structure and composition that can facilitate easier consumption by older adults. *Patients on modified diet had a median daily caloric intake of 852 kcal (IQR 787–926 kcal) compared to 631 kcal (IQR 506–797 kcal) in the standard group. * Taste, texture, palatability, and ease of intake for modified diet outperformed the standard. * The modified diet present substantial benefits to patient satisfaction.
Higashiguchi et al. (2017)	77.0 (SD 11.0)	Mixed	50	Japanese in-patients or residents in nursing care. Rated as Level 4 or 5 for dysphagia severity score, BMI 19.9 (SD 3.8) kg/m^2. Average number of teeth not reported.	22 centers in a randomised cross-over study	Traditional texture modified diet versus iEAT diet (foods softened by heat and enzyme homogeneous permeation)	Questionnaire on appearance, smell, easy to eat, easy to swallow, soft, tasty, enjoyable. Safety evaluation. Measurements of body weight and parameters.	* In patients with severe dysphagia, the study diet led to a significant increase in energy and protein consumption. * iEAT diet led to a significant increase in body weight. * No significant difference between the diets for taste, ease to eat, ease to swallow or softness. * The appearance satisfaction levels were higher for the study diet.
Liedberg et al. (2002)	68.0 (SD not provided)	Males	483	68-year-old Swedish community-dwelling adults, BMI not reported. Average number of teeth 22.4 (SD 4.0)	Clinical survey	Different food types (blanched almonds, chewing gum, hard and soft foods) used to evaluate chewing capacity.	Masticatory capacity, swallowing threshold, food intake.	* The group with over 24 natural teeth, had the best scores in the objective tests: bolus mixing, bolus shaping, and number of strokes to the first swallow, higher intake of foods included in the survey.
Kamei et al. (2024)	69.47 (SD 2.8)	Mixed	464	Japanese community-dwelling residents, BMI not reported. Average number of teeth not reported.	Questionnaire	Survey on 26 different food types. Responders clustered as into 4 groups: average-texture likers, firm-texture likers, low texture-preference (having low preference for both smoothness and firmness) and smooth-texture likers	Likert scale (7 points)	* Smooth-texture likers significantly more likely to be female * Smooth-texture likers experienced difficulties in accepting a variety of foods compared to firm-texture likers. * Smooth-texture likers enjoyed manipulating food with the tongue and palate.
	69.3 (SD 3.3)	Mixed	66	Survey participants who like/rather like Daifuku (Japanese confectionery), BMI not reported. Average number of teeth not reported.	Sensory evaluation & Questionnaire	Assessed smooth texture preference using questionnaires. Participants completed sensory evaluation of Daifuku with different smoothness.	VAS scale for texture attributes, liking (appearance, flavour, texture); measured eating time between bites.	* High smooth preference group showed 6.3 % increase in smoothness intensity perception. * Those with a high smooth preference had

(*continued on next page*)

Table 4 (*continued*)

Reference	Participant information				Study information			Outcomes
	Age	S	N	Participant details	Study design	Type of modification/ manipulation	Measurements	
Rothenberg et al. (2007)	Mean and SD not provided. 70–99 range.	Mixed	208	Swedish healthy participants in special or ordinary housing, BMI ordinary housing 25.5 (SD 3.1) and special house 23.9 (SD 4.5) kg/ m^2. Average number of teeth not reported.	Sensory evaluation & Questionnaire	TM carrot and meat products versus normal products	Oral processing, sensory perception, functional characteristics of food, acceptance and liking.	a significantly longer eating time (16.7 %). * All the tested products were easy to masticate and swallow. * Participants in assisted housing found the TM meat and carrot products easier to masticate and the meat product easier to swallow, than those in ordinary housing. * Mean values regarding ‘‘taste’’ indicated that people in ordinary housing had a higher preference for the three carrot products. * Impaired swallowing was most frequently reported in special housing participants (22 %).
Laguna et al. (2016)	79.94 (SD 9.57)	Mixed	30	Participants in community centers, private accommodation or nursing homes, both in Spain and UK. Average number of teeth not reported.	Dual-center sensory evaluation and observation of oral processing.	Model hydrocolloid gels (carrageenan and sodium alginate). Five commonly consumed foods (mild and mature cheddar, mozzarella, banana, canned diced potato).	Eating capability score (including grip strength, manual dexterity, oro-facial muscular capability), dental status, mastication, difficulty and liking of food.	* Eating capability was not related to oral residence time, or perceived difficulty. *Bite force differed by eating capability and by dental status, and influenced number of chews and liking. * Food hardness correlated with number of chews. * Oral residence time for gels significantly correlated with number of chews, liking and difficulty perceived. * Tongue pressure varied between people * Significant correlation between sample consumption time and number of chews * Having natural teeth led to higher biting force than wearing dentures * Gels rated between neutral and liked. Significant correlation between liking and time kept in mouth * Heterogeneity of the food matrix influenced the number of chews and time * Significant correlation between residence time and perceived difficulty with eating * Harder foods were kept in the mouth for significantly longer (more chews required)

SD – Standard Deviation, VAS – Visual Analogue Scale, S – Sex, N – Number of participants, TM – Texture modified.

Table 5
A summary of original studies that have addressed the factors influencing textural perception by older adults. These studies address the secondary research aim: to investigate the factors affecting textural perception without a specific outcome with regards to liking and consumption.

Reference	Participant information				Study information			Outcomes
	Age	S	N	Participant details	Study design	Type of modification/ manipulation	Measurements	
Geny et al. (2024)	Test 1: 74.6 (SE 0.4). Test 2: 74.1 (SE 0.5).	Mixed	106	French healthy older adults, BMI not reported. Average number of teeth not reported.	Sensory tests and questionnaire	Six food products either standard or protein fortified: Bolognese sauce, mashed potato and carrot soup; stuffed pepper, apple crumble and vanilla custard	Oral comfort, food liking and neophobia, chemosensory decline, health self-perception, appetite	* Food fortification resulted in texture alteration, with granular, sticky, and compact textures. * When the textural effect of fortification was accompanied by changes in taste and appearance, it led to decreased product liking.
Park et al. (2017)	Young adults: 26.28 (SD 2.78). Older adults: 79.53 (SD 3.48).	Mixed	60	Korean healthy participants with >25 natural teeth, BMI not reported. Average number of teeth not reported.	Cross-sectional study design.	Rice in four different hardness levels (cooked rice, soft-boiled rice, rice gruel, thin rice gruel)	Video-fluoroscopic swallowing study to assess number of chews, bolus transit time, and total duration in oral cavity.	* Rheological properties showed significant decrease in hardness across the four food options. * Number of chews and oral processing time significantly decreased as hardness decreased for both age groups. * Older adults showed significantly more chews than younger adults for all food types (except the softest). * The study recorded 4 aspects of bolus transit time, of these: * Post faucial aggregation time (a specific part of bolus transit time) significantly longer in older groups on consuming the rice gruel. * Valleculae aggregation time showed significant differences between the two age groups for all textures and significantly correlated with hardness and adhesiveness of foods in older but not in younger adults.
Kikuchi et al. (2021)	82.4 (SD 8.2)	Mixed	74	Japanese residents of long-term care institution, BMI not reported. Average number of teeth not reported.	Cross-sectional: Clinical examination and survey	Comparison of normal diet versus soft diet.	Dietary status General condition oral examination	* Number of activities of daily living requiring assistance smaller in subjects eating a normal diet vs those eating fluid boiled rice (rice gruel) ($p < 0.01$) * Subjects who ate a soft diet or gruel had no occlusal support. *Almost all subjects who ate a normal diet wore dentures, but only 38 % of subjects eating a soft diet and 40 % of those eating gruel wore dentures.
Kim and Lee (2021)	73.58 (SD 5.41)	Mixed	115	Korean healthy participants with permanent dentition, BMI not reported. Average number of teeth 17.77 (SD 4.89).	Clinical examination and questionnaire	n/a	* Oral examination * Stimulated salivary flow rate * Masseter muscle tone * Masticatory performance using 2-coloured gum for mixing ability index * Key food intake ability in questionnaire	* Mixing ability index significantly correlated with number of teeth and elasticity and stiffness of masseter muscles. * Key food intake ability score was significantly associated with number of remaining teeth. * Weak correlation between mixing ability index and key food intake ability scores with 40 % variability.
Kito et al. (2019)	75.6 (SD 5.6)	Mixed	86	Japanese community dwelling older adults, BMI 23.7 (SD	Cluster Randomized Controlled Trial	Control versus Intervention group: "munchy lunch" (foods	Oral function, physical properties and function.	* Between baseline to- 12 weeks tongue pressure increased significantly in the

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Table 5 (*continued*)

Reference	Participant information				Study information			Outcomes
	Age	S	N	Participant details	Study design	Type of modification/ manipulation	Measurements	
				3.6). Average number of teeth 18.70 (SD 9.40).		that require more chewing and improve oral function)		intervention group only * Body fat percentage and BMI decreased significantly in the intervention group but not in the control group * Normal walking speed increased significantly but only in the intervention group.
Stenman et al. (2012)	70.0 (SD not provided)	Mixed	561	70-year-old Swedish residents, BMI not reported. Average number of teeth 19.3 (SD 7.90).	Clinical examination and questionnaire	n/a	*Dental study for clinical variables, number of teeth and presence of dentures * OHIP-14 to assess oral health related quality of life	* No significant difference OHIP-14 score of men and women. * Using dentures, having chewing problems and dissatisfaction with appearance of teeth were significant independent variables associated with OHIP-14 score.
Yamada et al. (2017)	Young adults: 26.9 (SD 3.9). Older adults: 86.6 (SD 4.0).	Mixed	18	Japanese nursing home residents, BMI not reported. Average number of teeth not reported.	Cross-sectional	Control drink (thin rice and water) versus thicker and higher viscosity rice drinks	Video-fluoroscopic swallowing study, swallow initiation, respiration	* In older participants, swallowing was initiated during inspiration significantly more often (31.6 %) than in younger participants (5.6 %). * The timing of swallow initiation was delayed in older participants for thicker and higher-viscosity foods.

SD – Standard Deviation, OHIP – Oral Health Impact Profile, S – Sex, N – Number of participants.

changes which is hypothesised to impact textural perception (Mioche, Bourdiol and Peyron, 2004). Ageing is commonly associated with a loss of natural dentition and a shift to wearing dentures (Atanda et al., 2022). The impact of dentures on textural perception has been investigated. Liedberg et al. (2005) showed that wearing dentures significantly impacts masticatory capacity. Individuals with more than 24 natural teeth demonstrated significantly higher scores for bolus mixing, bolus shaping, number of strokes to the first swallow and overall food intake (Liedberg et al., 2002). This was supported by Laguna et al. (2016) who reported that having natural teeth led to higher biting forces than those wearing dentures, who displayed a reduced eating capability as a result of reduced biting force (Laguna et al., 2016). In addition, Stenman et al. (2010) reported that wearing dentures was predictive of poor self-reported oral health. These studies suggest that wearing dentures influences bite force, oral processing patterns, and oral health, which will impact the textural perception of food.

Whilst changes to dentition are known to significantly affect chewing efficiency in older adults, ageing is also associated with a relative decrease in masseter muscle strength, impacting bite force. Kim et al. (2021) showed that the mixing ability index was significantly associated with the number of teeth, and the tone, elasticity, and dynamic stiffness of the masseter muscles, indicating that these factors all impact the ability of an individual to form a bolus effectively in the oral cavity. In this study masticatory performance showed a weak but significant association with key food intake ability score (developed by assessment of chewing ability for five key food items), suggesting that properties of masticatory muscles should be evaluated alongside dental health when exploring improvement of masticatory function in this demographic (Kim & Lee, 2021). Another avenue which may affect eating capability is tongue strength; however, the high variability of tongue pressure reported in older adults by Laguna et al. (2016), meant it was not possible to conclude the effect this has on eating capability. This should be a direction for future research.

Age-associated changes in the physical properties of the oral cavity are common. However, these can be attenuated through adequate food choices. Kito et al. (2019) reported an increase in tongue pressure through the use of a "munchy lunch" with varied textures compared with traditional softer meals. This highlights that whilst some age-associated changes are unavoidable, others are the product of food choices and preferences which change with age. It is also possible that these food choices are influenced by the individuals' concerns about changes to their eating capability. As Rothenberg et al. (2007) noted, only a minority of those who reported swallowing problems had been evaluated or treated, meaning it may be these untreated conditions that are influencing texture perception. The impact of age-associated changes on the physical properties of the oral cavity may be reduced through seeking adequate dental treatment and, if appropriate, undertaking training to increase muscle strength: this is a gap in the literature for future research.

4.3. Food preference and acceptance by older adults

Textural perception is a combination of physical stimuli, influenced by oral processing and oral cavity physiology, and psychological interpretation of those cues (James, 2018). Therefore, an individual's textural preferences and liking of foods with given textures are likely to impact their perception of a food. Kamei et al. (2024) reported that individuals who were categorised as smooth-texture likers had a 6.3 % average increase in perception of smoothness intensity. This might be a psychological effect reflecting more broadly an aversion to more complex textures rather than a preference for smooth textures, due to a dynamic shift in voluntary attention towards smoothness (Kamei et al., 2024) or a reflection of differences in oral processing and eating rate, as previously discussed (section 4.1). The above highlights the impact of textural preferences on food perception as individuals are more likely to turn attention towards food attributes they have strong feelings towards. However, the magnitude of this is still to be determined and requires further research.

Another possibility is that older adults might prefer softer foods as they find them easier to masticate and have a reduced risk of

experiencing impaired swallowing. Rothenberg et al. (2007) and Laguna et al. (2016) both reported that older adults had increased liking of texturally modified foods compared with standard foods, as well as increased scores for ease of eating and acceptance. These factors may contribute to a feedback cycle where foods that are perceived as safer become preferred, impacting preferences and food choices. Individuals have a tendency to consider familiar foods as safe due to past experience (Aldridge et al., 2009). This highlights the importance of food familiarity on acceptance. Higashiguchi et al. (2017) found that a texturally modified diet was associated with significantly increased consumption compared with a standard diet, despite having no significant difference in textural perception. The study concluded that the difference in consumption was due to increased satisfactory appearance, suggesting that the acceptable appearance was able to mask the softening of the food. This suggests that visual perception, and psychological anticipation, significantly modify the sensory experience and is able to mask changes in modified foods. This highlights the importance of liking and acceptability in textural perception. Age-associated decline in taste is already regarded as important but this evidence suggests that a visual impairment and thus the ability to anticipate food texture, may additionally impact perception. This observation is supported by Geny et al. (2024) who reported that food fortification did not significantly impact liking until it reached levels where taste and appearance are altered. Appearance was listed in this study as a crucial factor for consumer acceptability (Geny et al., 2024).

The impact of eating behaviours on perception is important to consider when designing meal plans for older adults at risk of malnutrition. Crippa et al. (2023) showed that a texture-modified diet was associated with significantly higher texture and palatability scores compared to a standard diet. Taste was also scored higher on average but this was not significant (Crippa et al., 2023). The texture-modified diet showed a significant increase in consumption: this suggests not only is food with higher acceptability consumed in larger volumes, but that there is a correlation between palatability and textural appeal. Therefore, it is possible that modifications to improve textural acceptance of food will impact their taste and palatability. However, a limitation of this study is that participants were only asked to score 'texture', so it is unclear what attributes were significantly different in these diets, making comparisons with other studies limited. Nonetheless, this work highlights the importance of textural acceptance and liking on consumption, which will be clinically relevant for healthcare providers and carers aiming to increase the food consumption of patients through dietary modifications.

A final factor that is likely to impact textural perception is food familiarity. Laguna et al. (2016) reported that previous experience and familiarity with a food product were contributing factors in the liking scores of that product. Older adults scored unfamiliar gels in the neutral-to-liked zone, compared with familiar food products which were scored higher, indicating that they were able to discriminate foods better based on their past experience and familiarity (Laguna et al., 2016). Using examples that are more closely related to food applications could promote sensory perception by encouraging greater effort in sensory evaluation or heightened attention to food. This is supported by the perception of those categorised as 'smooth texture likers' in Kamei et al. (2024); however, this preference group may reflect those that limit the complex textures they normally consume due to limitations in dental or oral processing. It is noted that older adults tend to be unwilling to change established eating habits and overestimate their masticatory ability (Carlsson, 1984), even when ageing-related physical changes would otherwise limit their food choices. It is recognised that food familiarity or food neophobia is not always considered in studies with older adults (Soucier et al., 2019), meaning that the impact of those factors might be larger than currently indicated, and they should be considered in future work with this age group. The prevalence of food neophobia is higher in older adults than in the general adult population (Tuorila et al., 2001), further suggesting that limited food choices in this demographic may increase the risk of malnutrition. Soucier et al. (2019) highlighted the need for more research to better understand the causes of food neophobia in older adults, and particularly how it might relate to health conditions, medication and medical factors.

4.4. Categorisation of demographic differences

Participant demographics varied considerably within and between the studies reviewed, which limits conclusions that can be drawn about the relationship between demographics and textural perception. One example of this is nationality varying between study locations, which could be a confounding factor with familiarity when examining the impact of foods presented in different studies. Most studies chose foods familiar to their participants, however, these may be unfamiliar to participants of a different nationality or cultural background. For instance, Kamei et al. (2024) used Daifuku, a food that may not be widely recognised outside of Japan. It is also noted that some studies used foods that are likely to be unfamiliar to all participants, such as the gels seen in Laguna et al. (2016). All studies, except Liedberg et al. (2002), included both male and female participants, but few analyzed their findings by sex. As a result, differences in texture perception related to biological sex are difficult to conclude in this review, nonetheless, there were two exceptions. In the study of Geny et al. (2024), sex did not show a significant effect on liking or the oral processing scores of the different food products tested. However, Laguna et al. (2016) concluded that sex had a significant association with grip force, which is known to correlate with eating capability. This highlights the need for sex-specific research to enable targeted advice and intervention to be given to older adults.

Other variables that may be associated with texture perception and acceptability have not been provided in all studies. For example, BMI was only reported in 4 of the 13 studies reviewed, and in all of these BMI was within the normal range. Therefore, any association between BMI and textural perception cannot be investigated in this review. It is also noted that some studies used self-reporting to collect BMI data, which is recognised to be open to underestimation by participants (Rothenberg et al., 2007). Similarly, the reporting of the number of teeth varied between studies. Most studies required participants to have more than a certain number of teeth but did not report the average number or draw any conclusions about the effect of teeth number on their results. For example, Park et al. (2016) required participants to have more than 25 teeth but did not report the mean number or range. Without studies reporting teeth number, and including a greater range of dentition, the interpretation of the relationship between dentition and texture perception is limited.

4.5. Limitations in the literature

Important areas for future research have been mentioned throughout the discussion. It is important to acknowledge that direct comparison of studies is challenging due to differences in study design. For example, multiple studies were excluded from our review due to using 60 years as the minimum age for inclusion. This review used 65 years as the minimum age for older adults, as this is in keeping with the definition of older adults provided by the National Health Service (National Health Service, 2024). However, we recognise that this is not consistent across the literature and has led to the omission of studies. Standardisation of the term "older adult" is difficult due to cultural variation, access to medical care and lifespan. Current studies that include adults over the age of 65, show large variability in average age, with some studies displaying an average age of 68 and others of 82. The comparison of these studies is likely restricted by the differences between participants: future research should subdivide according to age the older adults' group to understand changes that continue to occur during advanced ageing. Heterogeneity is also recognised with the participant populations for factors such as cultural differences, socioeconomic status,

medication use, edentate or edentulous status, accommodation type, sex, and medical conditions: it is possible that these factors have influenced the studies' results. Due to the difficulties in recruiting older adults, participants with vastly different characteristics might have been pooled together, thus it is not possible to conclude the individual effect the above heterogeneity factors have on texture preferences and perception.

Standardisation of methodologies to quantify and benchmark oral processing capabilities is also required in the literature. For example, the methods used to measure eating ability show variation, with some studies using specific scoring systems (Laguna et al., 2016), and others utilising self-reported characteristics (Higashiguchi et al., 2017). This limits the comparisons that can be made between results and means it is not appropriate to perform a meta-analysis due to differences in data type. Specifically in the research of oral processing and perception, there are limited studies to date that have accurate oral processing profiling, diet, and anthropometric data in the same population, which does not enable accurate comparisons and conclusions to be drawn. Methodological improvements would enable the generation of more meaningful data through standardisation.

The authors recognise that this systematic review was based on a small number of studies from a limited range of geographic locations. This highlights the lack of research in this area to understand the factors that influence textural perception by older adults. Previous research has focused on age-associated changes to taste and flavour perception rather than texture, while existing work on texture has often omitted outcomes, such as liking, acceptance and consumption. The authors addressed this using a second results table (Table 5), which included the studies which were missing the outcome of the effect on liking, acceptance or consumption. However, there remains a lack of sufficient studies investigating the impact of textural perception on older adults on food liking and consumption which should be a focus of future research. This systematic review could assist in setting the foundations for future research to increase understanding of the factors influencing textural perception.

4.6. Limitations to the systematic review methodology

To understand all the factors that impact the textural perception of older adults, it was necessary to have a broad research question leading to a high number of papers being generated that had to be sorted manually, increasing the risk of subjective bias. However, this risk was reduced by manual sorting being completed independently by two researchers and any discrepancies between the two being discussed and resolved. An objective method using the PECO guidelines was implemented to reduce subjectivity when assessing the eligibility of studies. To ensure that the maximum number of papers was found, the authors chose to include studies that take place both at home, in hospital/care settings, and in research settings: it is possible that these environments will have differing effects on textural perception. However, the small number of studies in this area meant it was necessary to include all the above environments. It is also noted that the review only included papers published in English, meaning relevant work from other countries may have been omitted.

5. Conclusion

The aim of this review was to systematically examine the literature to determine the factors that influence textural perception by older adults. Through the assessment of six studies, and a further seven studies that were missing one or more relevant outcomes, the review identified three main areas that influence texture perception by older adults: (a) the oral manipulation and processing behaviours of food products within the oral cavity to produce a bolus, including eating rate, masticatory abilities and swallowing; (b) the physical properties of the oral cavity such as strength of mastication muscles, dentition, and tongue pressure; and (c) the individual factors that influence food preferences such as food familiarity, texture liking, and dietary patterns. The combination of these physical and psychological factors contributes to the textural perception of foods within the older demographic. The authors recognised that there are gaps in the understanding as a result of the existing literature focusing on changes to taste and aroma perception, rather than texture. However, texture significantly drives liking and intake of food products, meaning this is an important consideration in the design of foods for this demographic. It was shown that physical and sensory components must both be considered with regard to textural acceptance. Future studies should aim to understand how the above factors influence texture perception in older adults, focusing on and comparing characteristics such as sex, oral and general health parameters, eating capability as well as cultural and environmental influences.

CRediT authorship contribution statement

Holly Giles: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Dimitra Zannidi:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Miriam E. Clegg:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Jayne V. Woodside:** Writing – review & editing, Supervision. **Gerry McKenna:** Writing – review & editing, Supervision. **Ciarán G. Forde:** Writing – review & editing, Supervision. **Stephanie P. Bull:** Writing – review & editing, Supervision. **Stella Lignou:** Writing – review & editing, Supervision. **Joe Gallagher:** Writing – review & editing, Supervision. **Marianthi Faka:** Writing – review & editing, Supervision. **Lisa Methven:** Writing – review & editing, Supervision, Methodology, Conceptualization.

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Ethical statement

This systematic review analyzed existing published literature; therefore, no new human data was collected, and ethical approval was not required.

Declaration of competing interest

The authors declare no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2025.108202.

Data availability

No data was used for the research described in the article.

References

Aldridge, V., Dovey, T., & Halford, J. (2009). The role of familiarity in dietary development. *Developmental Review, 29*(1), 32–44.

Atanda, A. J., Livinski, A. A., London, S. D., Boroumand, S., Weatherspoon, D., Iafolla, T. J., & Dye, B. A. (2022). Tooth retention, health, and quality of life in older adults: A scoping review. *BMC Oral Health, 22*(1), 185.

Bolhuis, D. P., & Forde, C. G. (2020). Application of food texture to moderate oral processing behaviors and energy intake. *Trends in Food Science & Technology, 106*, 445–456.
Carlsson, G. E. (1984). Masticatory efficiency: The effect of age, the loss of teeth and prosthetic rehabilitation. *International Dental Journal, 34*(2), 93–97.
Cichero, J. (2016). Adjustment of food textural properties for elderly patients. *Journal of Texture Studies, 47*, 277–283.
Crippa, C., Matteucci, S., Pastore, M., Morenghi, E., Starace, E., De Pasquale, G., Pieri, G., Soekeland, F., Gibbi, S., Lo Cricchio, G., Zorloni, A., Mazzoleni, B., & Mancin, S. (2023). A comparative evaluation of the caloric intake and economic efficiency of two types of homogenized diets in a hospital setting. *Nutrients, 15*(22), 4731.
de Sire, A., Ferrillo, M., Lippi, L., Agostini, F., de Sire, R., Ferrara, P., Raguso, G., Riso, S., Roccuzzo, A., Ronconi, G., Invernizzi, M., & Migliario, M. (2022). Sarcopenic dysphagia, malnutrition, and oral frailty in elderly: A comprehensive review. *Nutrients, 14*(5), 982.
Ferrucci, L., & Kuchel, G. A. (2021). Heterogeneity of aging: Individual risk factors, mechanisms, patient priorities, and outcomes. *Journal of the American Geriatrics Society, 69*(3), 610–612.
Forde, C. G., & de Graaf, K. (2022). 1 Influence of sensory properties in moderating eating behaviors and food intake'. *Frontiers in Nutrition, 21*(9), Article 841444.
Ganbavale, S. G., Cai, Z., Mathers, J. C., Papacosta, O., Lennon, L., Whincup, P. H., Weyant, R., Wannamethee, S. G., & Ramsay, S. E. (2025). Association between poor oral health and deterioration of appetite in older age: Results from longitudinal analyses of two prospective cohorts from the UK and USA. *BMJ Open, 15*(2).
Geny, A., Brasse, C., Rognså, G., Filin, L., Nouri, L., Feyen, V., Szleper, E., Ueland, O., Smith, R., Methven, L., Maître, I., Van Wymelbeke-Delannoy, V., & Sulmont-Rossé, C. (2024). Acceptability of protein-fortified recipes in older adults in France. *Food Quality and Preference, 118*, Article 105205.
Higashiguchi, T., Ito, A., Nishiyama, H., Shigematsu, T., Ishikawa, A., Kato, H., Iijima, S., & Kikuchi, N. (2017). Appropriate nutritional management in patients with impaired mastication and those with mild dysphagia: A multicenter study of the usefulness of novel foods processed and softened by enzymes. *Asia Pacific Journal of Clinical Nutrition, 26*, 1007–1015.
James, B. (2018). Oral processing and texture perception influences satiation. *Physiology & Behavior, 193*(Pt B), 238–241.
Kamei, M., Nishibe, M., Araki, R., Kohyama, K., & Kusakabe, Y. (2024). Effect of texture preference on food texture perception: Exploring the role of matching food texture and preference. *Appetite, 192*, Article 107078.
Kikuchi, H., Komatsuzaki, A., Ono, S., Sirono, M., Motoi, S., Iguchi, A., & Susuga, M. (2021). Factors affecting dietary improvements in elderly residents of long-term care institutions receiving domiciliary dental care. *Medicines (Basel), 8*(11).
Kim, H., & Lee, H. (2021). Factors affecting subjective and objective masticatory function in older adults: Importance of an integrated approach. *Journal of Dentistry, 113*, Article 103787.
Kito, N., Matsuo, K., Ogawa, K., Izumi, A., Kishima, M., Itoda, M., & Masuda, Y. (2019). Positive effects of "textured lunches" gatherings and oral exercises combined with physical exercises on oral and physical function in older individuals: A cluster randomized controlled trial. *The Journal of Nutrition, Health & Aging, 23*, 669–676.
Laguna, L., Hetherington, M., Chen, J., Artigas, G., & Sarkar, A. (2016). Measuring eating capability, liking and difficulty perception of older adults: A textural consideration. *Food Quality and Preference, 53*, 47–56.
Liedberg, B., Norlén, P., Öwall, B., & Stolze, K. (2002). The masticatory handicap of wearing removable dentures. *Journal of Dental Research, 81*. B358-B358.
Makame, J., Nolden, A., & Emmambux, N. (2023). Texture properties of foods targeted for individuals with limited oral processing capabilities: The elderly, dysphagia, and head and neck cancer patients. *Food & Function, 14*, 3949–3965.
Mioche, L., Bourdiol, P., & Peyron, M. A. (2004). Influence of age on mastication: Effects on eating behaviour. *Nutrition Research Reviews, 17*(1), 43–54.
Morgan, R. L., Whaley, P., Thayer, K. A., & Schünemann, H. J. (2018). Identifying the PECO: A framework for formulating good questions to explore the association of environmental and other exposures with health outcomes. *Environment International, 121*(Pt 1), 1027–1031.
Namasivayam-MacDonald, A., Morrison, J., Steele, C., & Keller, H. (2017). How swallow pressures and dysphagia affect malnutrition and mealtime outcomes in long-term care. *Dysphagia, 32*, 785–796.
Narhi, T. O., Meurman, J. H., & Ainamo, A. (1999). Xerostomia and hyposalivation: Causes, consequences and treatment in the elderly. *Drugs & Aging, 15*, 103–116.
National Health Service, Age. (2024). *Inclusive content*. NHS England. . (Accessed 24 September 2024).
National Institute of Health. (2021). Quality assessment tool for observational cohort and cross-sectional studies. *Study Quality Assessment Tools*. Available at: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools Accessed: October 2024.
Office for National Statistics. (2022). *'Population and household estimates'*. . (Accessed 6 October 2024).
Park, H., Kim, D., Lee, S., & Park, K. (2017). The effect of aging on mastication and swallowing parameters according to the hardness change of solid food. *Journal of Texture Studies, 48*, 362–369.
Peyron, M., Woda, A., Bourdiol, P., & Hennequin, M. (2017). Age-related changes in mastication. *Journal of Oral Rehabilitation, 44*, 299–312.
Preston, J., & Biddell, B. (2021). The physiology of ageing and how these changes affect older people. *Medicine in Older Adults, 49*(1), 1–5.
Qin, Y., Pillidge, C., Harrison, B., & Adhikari, B. (2024). Pathways in formulating foods for the elderly. *Food Research International, 186*, Article 114324.
Rolls, B. J. (2006). The relationship between dietary energy density and energy intake. *Physiology & Behavior, 97*(5), 609–615.
Rothenberg, E., Ekman, S., Bulow, M., Moller, K., Svantesson, J., & Wendlin, K. (2007). Texture-modified meat and carrot products for elderly people with dysphagia: Preference in relation to health and oral status. *Scandinavian Journal of Food & Nutrition, 51*(4), 141–147.
Soucier, V. D., Doma, K. M., Farrell, E. L., Leith-Bailey, E. R., & Duncan, A. M. (2019). An examination of food neophobia in older adults. *Food Quality and Preference, 72*, 143–146.
Stenman, U., Ahlqwist, M., Björkelund, C., & Hakeberg, M. (2012). Oral health-related quality of life - Associations with oral health and conditions in Swedish 70-year-old individuals. *Gerodontology, 29*, E440–E446.
Tuorila, H., Lähteenmäki, L., Pohjalainen, L., & Lotti, L. (2001). Food neophobia among the finns and related responses to familiar and unfamiliar foods. *Food Quality and Preference, 12*(1), 29–37.
Vandenberghe-Descamps, M., Sulmont-Rossé, C., Septier, C., Feron, G., & Labouré, H. (2017). Using food comfortability to compare food's sensory characteristics expectations of elderly people with or without oral health problems. *Journal of Texture Studies, 48*, 280–287.
Wallace, M., O'Hara, H., Watson, S., Goh, A. T., Forde, C. G., McKenna, G., & Woodside, J. V. (2023). Combined effect of eating speed instructions and food texture modification on eating rate, appetite and later food intake. *Appetite, 184*, Article 106505.
World Health Organisation. (2024). Ageing and health. *Fact Sheet*. https://www.who.int/news-room/fact-sheets/detail/ageing-and-health. (Accessed 6 October 2024).
Xu, F., Laguna, L., & Sarkar, A. (2019). Aging-related changes in quantity and quality of saliva: Where do we stand in our understanding? *Journal of Texture Studies, 50*(1), 27–35.
Yamada, T., Matsuo, K., Izawa, M., Yamada, S., Masuda, Y., & Ogasawara, T. (2017). Effects of age and viscosity on food transport and breathing-swallowing coordination during eating of two-phase food in nursing home residents. *Geriatrics and Gerontology International, 17*, 2171–2177.