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Effects of Oral Health and Functional Characteristics on Taste Sensitivity in Older Adults: Comparative Analysis Using Solution and Taste Strip Tests

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ABSTRACT

Background: Taste sensitivity declines with age, adversely affecting dietary intake and quality of life. However, the effects of oral health and function on gustatory ability in older adults remain unclear.

Objective: To evaluate the relationship between oral health characteristics and taste sensitivity in older adults using solution and strip-based gustatory tests.

Methods: One hundred older adult participants (age: ≥ 65) were assessed for dental status, denture use, salivary flow, swallowing function, and subjective taste impairment. Taste sensitivity for five modalities was measured using solution and taste strip tests. Statistical analyses included group comparisons and correlation coefficients.

Results: Participants reporting subjective hypogeusia exhibited significantly lower total taste scores in solution and strip tests than those without ($p < 0.01$). Those with < 20 remaining teeth and users of mandibular dentures had lower umami scores than those with more teeth and no mandibular dentures ($p < 0.05$). Hyposalivation did not affect solution-based scores but was associated with lower total strip test scores ($p < 0.05$). Swallowing impairment was correlated with lower solution test scores, particularly for salty and umami ($p < 0.01$). Women had higher salivary flow and umami sensitivity, but overall gustatory function did not differ by sex. Solution and strip test scores were moderately correlated.

Conclusion: Taste perception in older adults is differentially influenced by salivary and swallowing functions, and the concordance between solution- and strip-based tests varies according to oral functional status and taste modality. Our results suggest that these methods capture complementary aspects of gustatory function and should be interpreted based on oral function in this population.

1 | Background

Progressive decline in sensory function, including taste perception, is a well-documented feature of human aging, and its clinical relevance in the older adult population is gaining increasing attention [1–3]. Impaired taste sensitivity can contribute to reduced appetite, nutritional imbalance, heightened disease susceptibility, and ultimately, diminished quality of life in older adults [4–6]. Thus, the accurate assessment and understanding of age-related gustatory dysfunction are pivotal for oral rehabilitation and general geriatric healthcare.

Hyo-Jung Jung and Hye Jin Lee have contributed equally to this study.

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Copious research has investigated how aging affects taste sensitivity, typically reporting a decline across sweet, sour, salty, bitter, and umami modalities [1, 7, 8]. However, the extent and pattern of these changes often differ considerably, depending on the objective assessment method used [1, 7]. Two principal approaches, taste solution tests and taste strip tests, are the most commonly adopted. The taste solution method, which uses aqueous solutions at graded concentrations, is regarded as more physiological because it stimulates the entire oral cavity. In contrast, the taste strip method delivers a fixed stimulus to specific oral regions, offering greater standardisation and enabling the diagnosis of localised dysfunction [7–9].

Despite their widespread use, the diagnostic accuracy and reliability of these objective tests remain controversial. Some studies have demonstrated moderate to good concordance between methods, but others report divergent outcomes for specific tastes or subgroups [10, 11]. Variability arising from test protocols, anatomical testing sites, oral moisture levels, and individual oral health status can influence the results and estimated prevalence of hypogeusia [7, 12]. A recent study by Westemeyer et al. compared liquid stimuli and dissolvable taste strips, demonstrating that liquids are generally perceived as more intense than strips, which suggests that these two modalities provide distinct sensory experiences rather than interchangeable measures [13]. However, their investigation was conducted in healthy adults to validate assessment protocols and primarily focused on sensory intensity and palatability. Consequently, it did not systematically assess how age-related changes in oral structure and function, such as reduced salivary flow, altered mucosal surfaces, or prosthetic rehabilitation, may differentially affect test outcomes. This limitation is particularly relevant in older adults, in whom compromised oral conditions are common and may substantially modify the delivery, dissolution, and perception of gustatory stimuli.

Despite this clinical relevance, few studies have directly compared these assessment techniques within a single older adult cohort, and even fewer have examined how individual oral characteristics affect test outcomes across both modalities [3, 7]. Comprehensive research integrating multiple objective tests in conjunction with a detailed evaluation of oral health variables is needed to establish clinically relevant diagnostic strategies and advance tailored interventions for taste disorders in the aging population [12, 14].

Therefore, the purpose of this study was to directly compare taste sensitivity in older adults using the solution and strip methods and to elucidate the influence of oral characteristics, such as dentition status, prosthesis use, salivary flow, and subjective hypogeusia, on gustatory function outcomes.

2 | Methods

2.1 | Study Participants

This study was approved by the Institutional Review Board of Yonsei University Dental Hospital, Seoul, Republic of Korea (IRB No. 2-2018-0032) and was conducted in accordance with the Declaration of Helsinki. Participants were recruited from welfare centres for older adults located in Seoul and Gyeonggi provinces between September 14, 2018, and December 13, 2019, by the Department of Orofacial Pain and Oral Medicine at Yonsei University Dental Hospital. Written informed consent was obtained from all participants before enrolment. Individuals aged ≥ 65 years, who were able to ambulate independently, and were willing to participate voluntarily were eligible for inclusion. Individuals with acute or chronic systemic diseases affecting gustatory or oral function (e.g., severe diabetes, neurological disorders, and recent upper respiratory tract infections), ongoing dental treatment, severe untreated dental or oral pain, or communication difficulties that would preclude valid test participation were excluded. Additional exclusion criteria included the use of medications known to affect taste perception or salivary flow within 1 month prior to enrolment.

A total of 100 participants (27 men and 73 women) were included in the final analysis. Demographic and clinical oral data, including dentition status, prosthesis use, salivary flow rate, and self-reported hypogeusia, were recorded for all participants. All assessments and interviews were conducted by calibrated examiners trained in the study protocol to minimise inter-rater variability.

2.2 | Questionnaire

Sociodemographic characteristics of the participants were investigated. In addition, data on smoking status, alcohol and drug use, medical history, and subjective decline in taste were collected. Subjective decline in taste was answered as 'Yes' or 'No'.

2.3 | Oral Examination

The number of remaining teeth was determined by counting the number of natural and restored teeth, excluding pontics, third molars, and residual roots. Denture use was also assessed.

2.4 | Measurement of Salivary Flow Rate

After verifying that no food other than water had been consumed for at least 1 h, unstimulated whole saliva (UWS) flow rates were measured. UWS was collected for 5 min using the spitting method. This method allowed the participants to spit saliva into a prescribed container once per minute for 5 min while sitting comfortably without external stimuli. The salivary flow rate per minute (mL/min) was calculated using the collected saliva. We used a cutoff value of < 0.2 mL/min to define salivary gland hypofunction [15, 16].

2.5 | Assessment of Swallowing Function

Swallowing function was evaluated using the repetitive saliva swallowing test (RSST), which assesses the ability to swallow saliva. The participants swallowed their saliva repeatedly for

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TABLE 1 | The concentrations of the taste solutions.

Taste	Material/Step	6	5	4	3	2	1[a]
Sweet	Sucrose (g/mL)	0.0048	0.0097	0.0195	0.039	0.0781	0.1563
Bitter	Quinine (g/mL)	0.00005	0.0001	0.0002	0.0004	0.0008	0.0016
Salty	Sodium chloride (g/mL)	0.0006	0.0012	0.0024	0.0048	0.0096	0.0192
Sour	Citric acid (g/mL)	0.0002425	0.000485	0.00097	0.00195	0.00391	0.00781
Umami	Monosodium glutamate (g/mL)	0.002	0.004	0.008	0.016	0.032	0.064

[a]Highest concentration of each taste solution.

TABLE 2 | The concentrations of the taste strips.

Taste modality	Concentration			
Sweet (sucrose, g/mL)	0.05	0.1	0.2	0.4
Bitter (quinine-hydrochloride, g/mL)	0.0004	0.0009	0.0024	0.006
Salty (sodium chloride, g/mL)	0.016	0.04	0.1	0.25
Sour (citric acid, g/mL)	0.05	0.09	0.165	0.3
Umami (MSG, g/mL)	0.016	0.04	0.1	0.25

Abbreviation: MSG, monosodium glutamate.

30 s while sitting comfortably. A trained researcher recorded the number of movements of the laryngeal prominence and elevation of the hyoid bone for 30 s. Based on previous studies, when the number of swallows was less than three, swallowing function was considered to be reduced [17].

2.6 | Taste Solution Method (Whole-Mouth Method)

Liquid solutions were used to assess gustatory function. The test consisted of 30 taste solutions [six concentrations of five tastants: sweet (sucrose), bitter (quinine hydrochloride), salty (sodium chloride), sour (citric acid), and umami (monosodium glutamate)]. The solution with the highest concentration of each tastant was step 1, and the solution with the lowest concentration was step 6 (Table 1). If the participants did not perceive the concentration at each step, they received a score of zero. Distilled water was used as the solvent. The concentrations of the solutions used in this study were based on those used in a previous study [18].

2.7 | Taste Strip Method

Burghart taste test strips (Burghart Messtechnik GmbH, Holm, Germany) were used in this study. Burghart taste strips are validated for the investigation of gustatory function. This is a simple and appropriate method of measuring taste sensitivity. The assay was performed according to the manufacturer's instructions. The taste strip test was divided into four concentrations of five flavours (sweet, bitter, salty, sour, and umami) and included two tasteless strips, comprising a total of 22 types of strips. Table 2 shows the concentrations of the taste strips.

The taste strips were placed in the middle of the anterior third of the protruding tongue. The participants were instructed to close their mouth, move their tongue slowly, and let the saliva dissolve the tastants in the strips. Before each test, the participants were asked to rinse their mouths with distilled water. If the perceived taste matched the actual taste of the strip, a score of 1 was assigned. The number of correctly identified tastes was summed to a 'taste score' for each taste quality and 'total (taste) score' (the sum of the five taste scores) for each participant [10, 19]. The score for each taste ranged from 0 to 4, and the total score from 0 to 20. The higher the taste score, the better the taste sensitivity.

2.8 | Statistical Analysis

The data collected in this study were analysed using IBM SPSS Statistics 25.0 (IBM Co., Armonk, NY, USA), and significance was set at $p < 0.05$. The characteristics of the participants according to sex were compared using the Mann–Whitney *U* and chi-square tests. Differences in taste scores based on subjective taste sensitivity were compared using the Mann–Whitney *U* test. Differences in taste scores based on oral function were analysed using the Mann–Whitney *U* test. Spearman's rank correlation coefficient was used to analyse the correlation between the gustatory function tests.

3 | Results

3.1 | Characteristics of Participants With Respect to Sex

Table 3 presents a comparison of oral function and taste sensitivity between the men and women. The women demonstrated significantly higher mean unstimulated salivary flow rates than the men ($p = 0.018$). Swallowing ability, as assessed using the Repetitive Saliva Swallowing Test (RSST), showed no significant sex differences. The prevalence of subjective taste impairment was comparable between men and women. Women had higher mean scores across all taste solution modalities; however, significant sex differences were observed only for umami taste ($p = 0.020$). Similarly, in the taste strip test, the mean scores for all modalities were higher for women than for men, but the difference was significant only for umami taste ($p = 0.027$).

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TABLE 3 | Characteristics of participants according to sex.

Variable	Total ($N=100$)	Men ($N=27$)	Women ($N=73$)	p
Age	75.88 ± 6.37	76.56 ± 6.22	75.63 ± 6.44	0.343[b]
Salivation (mL/min)	0.27 ± 0.17	0.23 ± 0.12	0.36 ± 0.23	0.018[b,*]
RSST	2.86 ± 0.89	2.59 ± 0.50	2.96 ± 0.98	0.101[b]
Subjective hypogeusia				
Yes	27 (27.0)	9 (33.3)	18 (24.7)	0.386[a]
No	73 (73.0)	18 (66.7)	55 (75.3)	
Taste score using solutions				
Sweet	4.35 ± 0.98	4.15 ± 1.38	4.42 ± 0.78	0.460[b]
Sour	3.88 ± 2.13	3.81 ± 2.43	3.90 ± 2.03	0.827[b]
Salty	2.47 ± 1.43	2.07 ± 1.64	2.62 ± 1.33	0.129[b]
Bitter	5.61 ± 0.92	5.52 ± 1.22	5.64 ± 0.79	0.878[b]
Umami	3.85 ± 2.3	2.81 ± 2.56	4.23 ± 2.11	0.020[b,*]
Total score	20.16 ± 5.18	18.37 ± 5.88	20.82 ± 4.76	0.061[b]
Taste score using strips				
Sweet	3.00 ± 1.01	2.85 ± 1.03	3.05 ± 0.10	0.310[b]
Sour	1.33 ± 1.04	1.30 ± 0.91	1.34 ± 1.08	0.958[b]
Salty	1.79 ± 1.22	1.74 ± 1.43	1.81 ± 1.14	0.820[b]
Bitter	2.10 ± 1.43	2.04 ± 1.37	2.12 ± 1.46	0.778[b]
Umami	1.30 ± 1.28	0.89 ± 1.22	1.45 ± 1.27	0.027[b,*]
Total score	9.50 ± 3.59	8.81 ± 3.56	9.75 ± 3.59	0.212[b]

Note: Values are presented as n (%) or mean ± standard deviation.
Abbreviation: RSST, repetitive saliva swallowing test.
[a]Chi-square test.
[b]Mann–Whitney U test.
*$p < 0.05$.

3.2 | Taste Sensitivity Score Using Taste Solution According to the Characteristics of the Older Adults

Table 4 shows the taste sensitivity scores obtained using the taste solution method according to various clinical and oral characteristics. Participants with subjective hypogeusia demonstrated significantly lower total taste solution scores than those without ($p=0.001$). Specifically, significantly reduced scores were observed for the salty ($p=0.015$), bitter ($p=0.002$), and umami ($p=0.006$) modalities in the hypogeusia group, whereas sweet and sour tastes did not differ significantly. The total taste solution score did not differ significantly based on whether the participants had <20 remaining teeth, or ≥20. However, the umami scores were significantly lower in the group with <20 teeth than in those with more teeth ($p=0.021$). No significant differences were observed in the total solution taste scores according to maxillary denture status. Participants with mandibular dentures had slightly lower total scores than those without. Notably, the umami scores were significantly lower in participants with mandibular dentures than in those without ($p=0.004$). The total solution taste score did not differ significantly between participants with normal salivation and those with hyosalivation, and no individual taste modality exhibited a significant difference based on the salivation status. Participants with preserved swallowing function (RSST ≥3) had significantly higher total taste solution scores than those with impaired swallowing ($p=0.003$). Salty ($p=0.001$) and umami ($p=0.006$) scores were also significantly higher in the RSST ≥3 group than in those with impaired swallowing, while other taste modalities were not significantly affected.

3.3 | Taste Score Using Taste Strips According to the Characteristics of the Older Adults

Table 5 summarises the taste sensitivity scores obtained using the taste strip method according to clinical and oral characteristics. Participants with subjective hypogeusia had significantly lower total taste strip scores than those without ($p=0.003$). In particular, the hypogeusia group exhibited significantly lower scores for the sour ($p=0.002$), bitter ($p=0.021$), and umami ($p=0.023$) modalities. The scores for sweet and salty tastes did not differ significantly between groups. No significant differences were noted in the total or individual taste strip scores according to whether the participants had <20 remaining teeth or ≥20. The total and individual taste strip scores did not show significant differences based on the presence of maxillary or mandibular dentures.

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TABLE 4 | Taste score using solutions according to the characteristics of the older adults.

		Sweet	Sour	Salty	Bitter	Umami	Total score
Variable	***N***	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Subjective hypogeusia							
No	73	4.38 ± 0.94	4.15 ± 1.20	2.67 ± 1.31	5.82 ± 0.39	4.27 ± 2.10	21.30 ± 4.43
Yes	27	4.26 ± 1.10	3.15 ± 2.35	1.93 ± 1.62	5.04 ± 1.53	2.70 ± 2.52	17.07 ± 5.83
p-value		0.592	0.054	0.015*	0.002**	0.006**	0.001**
The number of remaining teeth							
≥ 20	74	4.35 ± 0.88	3.82 ± 2.14	2.61 ± 1.30	5.61 ± 0.99	4.14 ± 2.24	20.53 ± 5.15
< 20	26	4.35 ± 1.23	4.04 ± 2.14	2.08 ± 1.72	5.62 ± 0.70	3.04 ± 2.38	19.12 ± 5.21
p-value		0.495	0.635	0.190	0.716	0.021*	0.231
Mx denture							
No	78	4.31 ± 0.90	3.81 ± 2.14	2.53 ± 1.37	5.55 ± 1.00	3.99 ± 2.27	20.18 ± 5.20
Yes	22	4.50 ± 1.23	4.14 ± 2.15	2.27 ± 1.63	5.82 ± 0.50	3.36 ± 2.46	20.09 ± 5.20
p-value		0.113	0.589	0.529	0.173	0.270	0.990
Mn denture							
No	72	4.32 ± 0.90	3.90 ± 2.16	2.47 ± 1.39	5.64 ± 0.86	4.24 ± 2.17	20.57 ± 5.07
Yes	28	4.43 ± 1.17	3.82 ± 2.11	2.46 ± 1.55	5.54 ± 1.07	2.86 ± 2.42	19.11 ± 5.39
p-value		0.339	0.753	0.832	0.895	0.004**	0.239
Salivation							
normal	59	4.37 ± 1.08	3.97 ± 2.10	2.61 ± 1.45	5.64 ± 0.83	3.64 ± 2.39	20.39 ± 5.57
hyposalivation	41	4.32 ± 0.82	3.76 ± 2.20	2.37 ± 1.43	5.56 ± 1.05	4.15 ± 2.20	20.00 ± 4.93
p-value		0.781	0.631	0.419	0.659	0.288	0.713
RSST							
≥ 3	66	4.45 ± 0.90	4.06 ± 2.02	2.80 ± 1.36	5.64 ± 0.87	4.30 ± 1.99	21.26 ± 4.73
< 3	34	4.15 ± 1.11	3.53 ± 2.33	1.82 ± 1.36	5.56 ± 1.02	2.97 ± 2.66	18.03 ± 5.40
p-value		0.137	0.240	0.001**	0.692	0.006**	0.003**

Note: Values are presented as mean ± standard deviation. Using the Mann–Whitney *U* test.
Abbreviation: RSST, repetitive saliva swallowing test.
*$p < 0.05$.
**$p < 0.01$.

Participants with normal salivary flow had significantly higher total taste strip scores than those with hyposalivation ($p = 0.033$). No individual taste modality showed a significant difference according to salivation status, although a trend toward higher scores was observed in the normal salivation group. No significant differences in total or individual taste strip scores were observed between participants with preserved swallowing function (RSST ≥ 3) and those with reduced swallowing function.

3.4 | Correlation of the Taste Score Between the Two Tests

Table 6 shows the correlation coefficients evaluating the association between the taste solution and taste strip test scores for each taste modality as well as the total taste score.

Total population ($n = 100$): Significant positive correlations were observed between the results of the two taste testing methods across all taste qualities and the total taste score. The correlation coefficients were as follows: sweet ($r = 0.164$, $p < 0.05$); sour ($r = 0.393$, $p < 0.01$); salty ($r = 0.289$, $p < 0.05$); bitter ($r = 0.383$, $p < 0.01$); umami ($r = 0.549$, $p < 0.01$); and total taste score ($r = 0.493$, $p < 0.01$).

Subgroup after excluding the hyposalivation and swallowing function decline groups ($n = 36$): The overall pattern of correlations was largely maintained: the coefficients for sweet ($r = 0.141$, $p < 0.05$), salty ($r = 0.281$, $p < 0.05$), and the total score ($r = 0.456$, $p < 0.01$) were similar to those in the total sample, whereas the correlations for bitter ($r = 0.415$, $p < 0.01$) and especially umami ($r = 0.653$, $p < 0.01$) increased, and that for sour ($r = 0.185$, $p < 0.05$) decreased.

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TABLE 5 | Taste score using strips according to the characteristics of the older adults.

Variable	N	Sweet	Sour	Salty	Bitter	Umami	Total score
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Subjective hypogeusia							
No	73	3.04 ± 0.94	1.52 ± 1.04	1.86 ± 1.17	2.30 ± 1.37	1.44 ± 1.23	10.14 ± 3.43
Yes	27	2.89 ± 1.19	0.81 ± 0.83	1.59 ± 1.34	1.56 ± 1.48	0.93 ± 1.36	7.78 ± 3.50
p-value		0.798	0.002**	0.344	0.021*	0.023*	0.003**
Number of remaining teeth							
≥ 20	74	3.01 ± 0.99	1.39 ± 1.06	1.78 ± 1.19	2.16 ± 1.43	1.35 ± 1.27	9.68 ± 3.48
< 20	26	2.96 ± 1.08	1.15 ± 0.97	1.81 ± 1.33	1.92 ± 1.47	1.15 ± 1.32	9.00 ± 3.90
p-value		0.907	0.351	0.894	0.465	0.406	0.307
Mx denture							
No	78	3.01 ± 0.97	1.36 ± 1.04	1.77 ± 1.21	2.04 ± 1.46	1.28 ± 1.29	9.44 ± 3.58
Yes	22	2.95 ± 1.13	1.23 ± 1.02	1.86 ± 1.28	2.32 ± 1.32	1.36 ± 1.33	9.73 ± 3.68
p-value		0.993	0.674	0.755	0.432	0.809	0.917
Mn denture							
No	72	2.97 ± 0.99	1.35 ± 1.04	1.79 ± 1.20	2.13 ± 1.40	1.36 ± 1.29	9.57 ± 3.52
Yes	28	3.07 ± 1.05	1.29 ± 1.05	1.79 ± 1.29	2.04 ± 1.53	1.14 ± 1.27	9.32 ± 3.83
p-value		0.530	0.707	0.994	0.805	0.403	0.579
Salivation							
Normal	59	3.12 ± 0.79	1.46 ± 0.97	1.98 ± 1.32	2.25 ± 1.45	1.32 ± 1.40	10.14 ± 3.42
Hyposalivation	41	2.83 ± 1.24	1.15 ± 1.11	1.51 ± 1.00	1.88 ± 1.40	1.27 ± 1.10	8.59 ± 3.37
p-value		0.158	0.140	0.057	0.198	0.837	0.033*
RSST							
≥ 3	66	3.00 ± 1.04	1.41 ± 1.05	1.92 ± 1.23	2.12 ± 1.40	1.30 ± 1.24	9.93 ± 3.63
< 3	34	3.00 ± 0.94	1.18 ± 0.99	1.53 ± 1.16	2.06 ± 1.52	1.29 ± 1.36	9.06 ± 3.52
p-value		1.000	0.289	0.125	0.838	0.974	0.380

Note: Values are presented as mean ± standard deviation. Using the Mann–Whitney *U* test.
Abbreviation: RSST, repetitive saliva swallowing test.
*$p < 0.05$.
**$p < 0.01$.

4 | Discussion

This study comprehensively evaluated the effects of various oral and general health characteristics on taste sensitivity in older adults using solution and taste strip tests for all five primary taste qualities. These findings provide new insights into the complex and multifaceted interactions among oral condition, subjective symptoms, and objective gustatory function.

4.1 | Subjective Hypogeusia and Objective Taste Loss

Our results showed that older adult participants with subjective hypogeusia displayed significantly lower total taste scores, especially in the salty, bitter, and umami modalities, for both measurement methods. This close association between subjective symptoms and objective deficits emphasises the importance of systematically assessing older adults who report taste loss, as their complaints likely reflect genuine, quantifiable impairments [20]. These findings are consistent with those of previous studies, which have demonstrated that self-reported taste reduction often correlates with reduced gustatory sensitivity, particularly for modalities beyond sweet and sour [11, 21].

4.2 | Oral Health Factors: Tooth Loss and Denture Use

A low number of remaining teeth and mandibular denture wearing were both selectively associated with lower umami

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TABLE 6 | Correlation between the taste scores for the solutions and strips.

			Solutions					
			Sweet	**Sour**	**Salty**	**Bitter**	**Umami**	**Total score**
Total ($N=100$)	Strips	Sweet	0.164*					
		Sour		0.393**				
		Salty			0.289*			
		Bitter				0.383**		
		Umami					0.549**	
		Total score						0.493**
Excluding the hyposalivation and swallowing function decline groups ($N=36$)	Strips	Sweet	0.141*					
		Sour		0.185*				
		Salty			0.281*			
		Bitter				0.415**		
		Umami					0.653**	
		Total score						0.456**

Note: Using Spearman's rank correlation coefficient.
*$p < 0.05$.
**$p < 0.01$.

sensitivity in the solution test, whereas their overall impact on total taste ability was limited. This taste-modality-specific impairment pattern reflects the unique physiological characteristics of umami perception. Umami sensitivity has been shown to be particularly vulnerable to age-related physiological changes and oral structural alterations, resulting in significant impairment in older populations [22]. Unlike other basic tastes, umami perception involves complex receptor-mediated mechanisms that require glutamate detection and nucleotide potentiation [23, 24]. Effective umami perception requires adequate tastant dissolution, spatial distribution across multiple oral sites, and coordinated tongue–palate contact processes, all of which are compromised in individuals with extensive tooth loss or denture use [3, 14]. Individuals with fewer than 20 remaining teeth exhibit reduced masticatory efficiency and altered chewing patterns, which limit mechanical food breakdown and taste compound release. Additionally, mandibular dentures disrupt the dynamic oral sensory processes essential for umami perception by altering tongue position, mobility, and tongue–palate contact patterns. These results highlight the importance of comprehensive prosthetic rehabilitation and optimisation of oral function to preserve umami sensitivity and support adequate protein intake through umami-rich foods in edentulous or partially edentulous older adults.

4.3 | Salivation and Swallowing Function as Modifiers of Taste Assessment

In our study, 24.4% of older adults with hyposalivation (10 of 41 participants) reported a subjective taste impairment lower than the overall prevalence of hypogeusia (27.0%), reflecting the discordance between objective hyposalivation and subjective taste complaints commonly observed in older populations [21]. This discrepancy reflects the fact that hyposalivation primarily interferes with taste perception during food consumption, where adequate salivary flow is required for tastant dissolution and transport rather than directly impairing basal chemoreceptor sensitivity [21, 25]. Consistent with this mechanism, hyposalivation was associated with significantly reduced taste strip scores, but not solution-based scores, indicating a greater impact of saliva-mediated tastant extraction [12, 26, 27].

In contrast, participants with reduced swallowing function exhibited a higher prevalence of subjective taste impairment (32.4%) and significantly lower solution-based saltiness and umami scores. This pattern suggests a distinct mechanism whereby dysphagia-related sensorimotor dysfunction, rather than impaired chemical dissolution, disrupts taste perception. Specifically, compromised tongue–palate contact and reduced lingual propulsion are likely to impair whole-mouth sensory integration, which is critical for solution-based taste evaluation, while exerting minimal influence on localised strip testing [14, 28, 29].

Collectively, these findings demonstrate that hyposalivation and swallowing dysfunction affect taste perception via distinct chemical and sensorimotor pathways. This mechanistic heterogeneity highlights the need to interpret taste assessment outcomes according to the specific test modality used, particularly in older adults with co-existing oral functional impairments.

4.4 | Sex Differences and Other Variables

Women had higher unstimulated salivary flow rates and higher umami scores in both the solution and strip tests than did men, whereas most other taste scores and oral functional parameters

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did not differ significantly between the sexes. These findings are consistent with previous reports indicating minimal sex-related differences in overall taste sensitivity among older adults [4, 30, 31].

This selective umami advantage in women reflects a combination of hormonal and anatomical factors. Oestrogen receptors are abundantly expressed in fungiform taste papillae, particularly within the type II taste cells responsible for umami transduction, with expression patterns declining after menopause [3, 22], Additionally, women exhibit a higher density of fungiform papillae than men, a structural advantage that is better preserved with advancing age [32]. Women's superior salivary flow rates further contribute to umami perception because salivary secretion is essential for umami receptor activation via nucleotide-mediated potentiation mechanisms [22, 24]. In contrast, the absence of sex differences in other taste modalities aligns with the evidence that hormonal modulation of non-umami tastes becomes minimal after menopause when circulating oestrogen levels equilibrate between sexes [30].

4.5 | Methodological Insights: Concordance of Solution and Strip Tests

A key strength of this study is that it directly compared the solution and taste strip methods, providing important methodological insights into the concordance between tests. In all participants, moderate correlations were observed across most taste qualities; however, when participants with hyposalivation or reduced swallowing function were excluded, the concordance between methods did not improve uniformly, but instead varied by taste quality.

Specifically, the correlations for bitter and umami tastes improved among participants with preserved salivary flow and swallowing function, indicating that these taste qualities are most consistently assessed under stable oral conditions. This finding suggests that bitter and umami perception relies predominantly on robust chemoreceptor sensitivity, allowing both whole-mouth (solution-based) and localised (strip-based) stimulation to yield comparable sensory estimates when the oral sensorimotor function is intact [14, 33].

In contrast, concordance for sour taste decreased even in the absence of oral dysfunction, highlighting fundamental methodological differences between the two testing approaches. Sour perception depends on the integration of gustatory and trigeminal somatosensory inputs, which are differentially engaged in the two methods [34]. Solution testing involves the widespread distribution of acidic stimuli across the oral cavity, thereby activating both sensory systems, whereas strip testing provides focal gustatory stimulation with limited trigeminal involvement [35, 36]. As a result, divergent sour taste estimates reflect differences in sensory integration rather than poor reliability or methodological inadequacy.

Collectively, these findings indicate that solution- and strip-based tests capture distinct yet complementary aspects of gustatory function. Their combined use allows for a more comprehensive characterisation of taste perception and dysfunction than reliance on either method alone, particularly in older adults with a heterogeneous oral functional status.

4.6 | Clinical and Research Implications

Taste dysfunction in older adults should be recognised as a multidimensional clinical condition involving oral structural integrity, salivary physiology, and oropharyngeal sensorimotor dynamics, rather than as an isolated sensory deficit [37]. The results of this study demonstrate that solution-based and strip-based taste tests capture complementary aspects of oral function and suggest that clinical interpretation of taste test results should be made in the context of a comprehensive assessment of dental status, prosthetic status, salivary flow, and swallowing ability.

From a clinical perspective, the management of taste impairment in older adults should prioritise the identification and correction of modifiable oral functional contributors. The optimisation of prosthetic rehabilitation, interventions to enhance salivary flow, and targeted swallowing rehabilitation may mitigate taste dysfunction and its downstream nutritional consequences. In particular, umami sensitivity has emerged as a clinically salient indicator, given its consistent association with tooth loss, denture use, salivary function, swallowing performance, and protein-related dietary intake [38]. Therefore, the preservation or restoration of umami perception may represent a strategic therapeutic target for supporting appetite and nutritional adequacy in aging populations.

From a research standpoint, these results underscore the need for greater methodological standardisation and functional stratification in gustatory assessment studies involving older adults. Future investigations should incorporate multidimensional oral function profiling to clarify the mechanistic pathways underlying taste impairment and improve comparability across studies. Longitudinal and interventional research designs are essential to determine whether targeted oral functional interventions can causally improve taste sensitivity and related nutritional outcomes. Establishing such evidence is critical for integrating comprehensive taste assessment and management into routine geriatric care frameworks.

4.7 | Limitations

This was a cross-sectional study limited to a relatively healthy, community-dwelling older adult population. Therefore, the results may not be generalisable to institutionalised or medically complex populations. Further research with larger, more diverse cohorts and longitudinal designs is warranted.

5 | Conclusions

Age-related decline in taste sensitivity among older adults is strongly influenced by subjective symptoms, oral health status, saliva production, and swallowing ability. These factors not only affect the measured gustatory function but also moderate the concordance between different testing methods.

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Comprehensive, individualised approaches that address oral and systemic health are essential for the effective management of taste disorders in aging populations.

Author Contributions

Hyo-Jung Jung: conceptualisation, methodology, data curation, validation, resources, writing original draft. **Hye Jin Lee:** methodology, investigation, data curation, formal analysis, writing original draft. **Yehin Cho:** investigation, resources. **Hyung-Joon Ahn:** conceptualisation, project administration, supervision, funding acquisition, writing review and editing.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Peer Review

For transparency, the peer review documents associated with this article are available at https://doi.org/10.1111/joor70178.

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