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RESEARCH

Insights into salt perception and cognitive impairment among middle-aged and older adults: a scoping review

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Abstract

Background A decline in taste sensitivity from aging leads people with a higher salt threshold to frequently add more salt to their food, which attributed to decreased cognitive efficiency. This scoping review aimed to gather the latest evidence on the relationship between salt perception and cognitive impairment which is essential in the development of new intervention and prevention strategies.

Methods Studies published between January 2014 and March 2024 were searched across four databases: PubMed, the Cochrane Library, Scopus, and EBSCO. Data extraction involved gathering details on the study design, participant demographics, methods for assessing cognitive function and salt perception, considering confounding factors, and synthesizing the primary outcomes.

Results Six studies were included in the analysis, five cross-sectional studies and a longitudinal study. These studies revealed various associations between salt perception and cognitive impairment. Specifically, findings from a three-year longitudinal study suggested that lower salt sensitivity was associated with poorer cognitive scores, which is consistent with the results of two other studies. However, the remaining three studies did not find significant differences ($p > 0.05$) in salt taste perception related to cognitive status. Furthermore, a study identified executive function as another significant factor influencing salt taste perception.

Conclusion These findings highlight the link between cognitive decline in salt perception, which provide an indication of salt intake and related health risks. There is a need to explore the mechanisms of salt taste sensitivity and its impact on cognitive health should be encouraged.

Keywords Cognitive impairment, Salt perception, Salt sensitivity, Executive function, Middle-aged adults, Older adults

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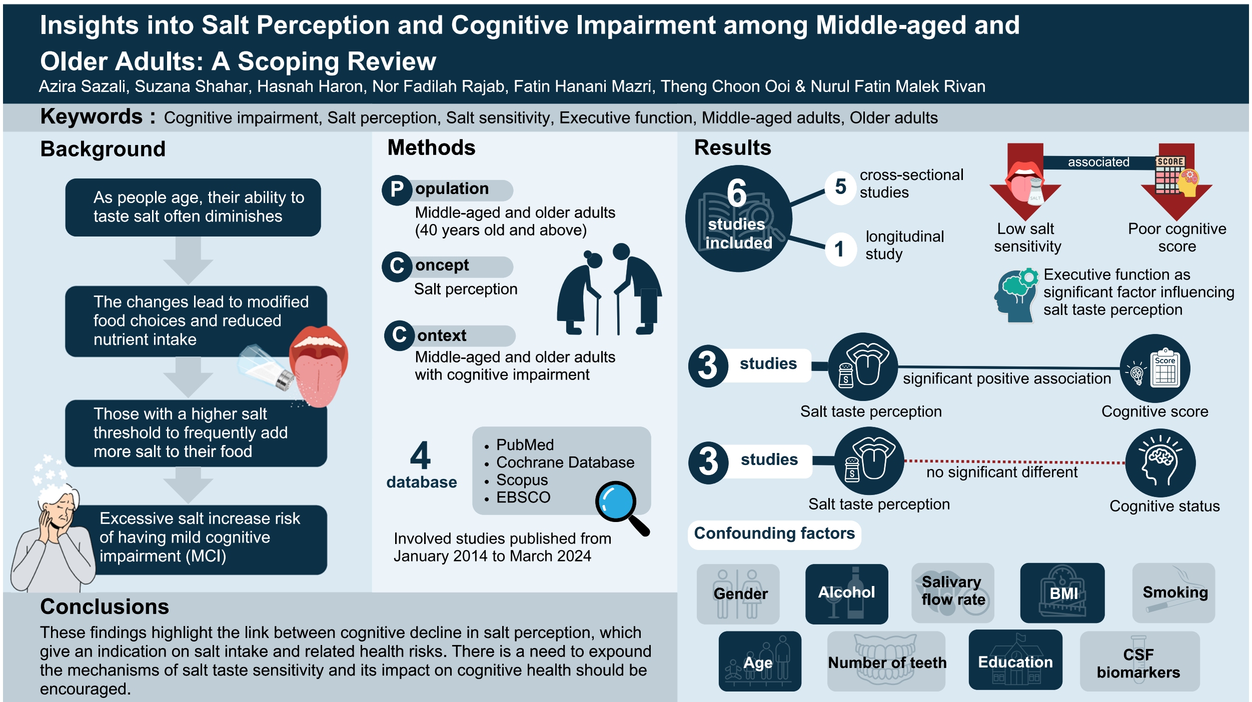
Graphical Abstract



Background

As people age, a decline in their senses can lead to negative health consequences. Changes in chemosensory perception may result in maladaptive food behavior, such as the addition of more salt to achieve the same taste intensity [1]. The decline in taste sensitivity in older adults may be partially due to the loss of taste receptors resulting from age-related physiological changes [2]. Furthermore, the increased use of medications in older adult individuals may affect their oral health, impacting their sense of taste [3]. Poor oral conditions, such as cavity infections, nerve damage, and reduced saliva production, have also been suggested as contributing factors to taste alterations [4]. In addition, malnutrition can both cause and result from changes in taste perception. As individuals age, alterations in taste linked to their nutritional status can diminish appetite, leading to altered food choices and lower nutrient intake [5, 6].

Previous studies have indicated that the most significant increase in the taste recognition threshold among older adults is sour and bitter flavour, while their ability to perceive salty, sweet, and umami tastes tends to decline with age [7, 8]. The reduced salivary function and atrophy of tongue papillae, resulting in a smoother appearance of the dorsal tongue associated with aging, may affect the perception of salty taste in older adults [9, 10]. Older adults with taste loss tend to increase their consumption of sweet and salty foods to achieve taste satisfaction when their taste sensitivity is heightened. The consumption of high levels of salt reduces sensitivity to taste, prompting individuals to consume even more salt to achieve the same level of taste satisfaction [11]. Despite that sodium is an essential nutrient that must be obtained from the diet, the habits of using salt and consuming highly processed foods contribute to excessive intake and negative health effects [12]. It's interesting to note that two studies found that those who had a higher threshold for salt also tend to add salt to their food more frequently [13, 14].

Although a high intake of salt in the diet is frequently associated with hypertension, few studies have shown that its effects go beyond just raising blood pressure; they have also been connected to cardiovascular disease and stroke [15, 16]. Further, it is associated with cognitive impairment, which has been related to dementia, including Alzheimer's disease (AD), and severe neurocognitive disorders (NCDs). The pathogenic process of AD starts decades before signs of cognitive impairment, a typical issue in older adults, appear. Between the more severe cognitive decline associated with dementia and the typical aging-related cognitive loss, there is a stage known as mild cognitive impairment (MCI). It can be characterize as having preserved global cognitive functions and daily activities [17]. People with Parkinson's disease (PD) are six times more likely to have cognitive impairment, and their salt taste sensitivity has declined even in the early stages of the condition, potentially increasing their salt consumption [18].

In recent studies, Rivan et al. [19] highlighted the association between high salt intake and mild cognitive impairment (MCI), whereas Liu et al. [20] identified excessive salt intake as an independent risk factor for the development of dementia and cognitive impairment in older adults. In animal experiments, Chugh et al. [21] found that whereas a high-salt diet had no effect on younger rats, it did reduce memory performance in older rats. Similarly, a recent study found that when given control or low-salt diets, aged rats showed an improvement in long-term memory but a deterioration in short-term memory [22]. Overall results were mixed, however, as a bigger study of older persons found no significant association between sodium intake and cognitive impairment [23].

While the link between salt intake and cognitive decline has been extensively researched, little is known regarding the potential influence of salt taste perception as a separate factor that might influence salt intake. Thus, the objective of this scoping review was to consolidate the latest evidence regarding the link between salt perception and cognitive impairment. It may offer unique insights into early markers of cognitive decline since taste perception, particularly salt sensitivity, can be affected by both neurological and physiological changes potentially strengthening the relation. By taking into account a variety of cognitive impairment, the results can be more broadly generalized and show patterns that hold true for different levels of cognitive impairment. This offers a more thorough comprehension of the connection between salt perception and cognitive decline. Variations in the way people with mild cognitive impairment, Parkinson's disease, or Alzheimer's disease perceive salt can reveal important mechanisms in the brain's processing of taste and sensory data, providing insight into the course of cognitive decline. The insights gained from this review may help direct the development of novel intervention techniques centered on sensory assessments of health and preventative care, eventually supporting public health initiatives to lessen the effects of cognitive decline on a worldwide scale.

Methods

This scoping review explored the connection between salt taste perception and cognitive impairment in middle-aged and older adults. It was conducted following the Arksey and O'Malley framework and the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) guidelines [24]. The PRISMA-ScR checklist is included in this review. The applied methodology comprises the five stages detailed below.

Identifying the research questions

The objective of this scoping review is to outline the current understanding of the relationship between salt perception and cognitive impairment in middle-aged and older adults. To guide the review and identify pertinent studies, a specific research question was formulated. Consequently, this scoping review aims to address the following research questions:

1. What are the assessments used to assess the salt perception and cognitive status of middle-aged and older adults?
2. What is the impact of salt perception on the cognitive status of middle-aged and older adults?

Identifying relevant studies

Search terms

Studies deemed relevant and published from January 2014 to March 2024 were analysed, spanning a decade. The Population, Concept, and Context (PCC) framework in Table 1 served as a guiding tool during this stage. The focus of this scoping review was on the salt perceptions of middle-aged and older adults facing cognitive impairment. Two reviewers (N.F.M.R. and A.S.) meticulously examined the MEDLINE Medical Subject Headings (MeSH) for terms associated with salt perception and cognitive decline. Consequently, the search terms utilized in this review are shown in Table 2.

Table 1 Table of PCC- Population, Concept and Context

Population	**Middle-aged and older adults (40 years old and above)**
Concept	Salt perception
Context	Middle-aged and older adults with cognitive impairment

Table 2 Search strings for the scoping review

Search string 1	Salt OR sodium OR gustatory OR taste
Search string 2	Perception OR intensity OR sensitivity OR threshold OR recognition OR detection
Search string 3	Cognitive OR cognition
Search string 4	Impairment OR disorder OR abnormality OR ageing OR deficiency OR deficit OR disturbance OR dysfunction OR degradation OR inability OR limitation
Search string 5	Search string 1 AND Search string 2 AND Search string 3 AND Search string 4

The inclusion criteria for articles were as follows: 1) review articles and secondary sources were not included; only primary studies were, 2) written in English to preserve accuracy and consistency and to avoid misunderstandings brought on by linguistic problems. 3) peer-reviewed full-text papers that offer comprehensive information needed for a detailed analysis, 4) research examining salt perception and cognitive status to make sure the study remains related to interest and 5) published within the last ten years (2014–2024) to ensure they are up to date with the latest advancements of regulations, dietary patterns, and health care. Articles not meeting these criteria were excluded. The included studies nevertheless provide insightful information in a range of circumstances, despite the fact that this may limit generalizability slightly.

Databases

Four databases were queried in this review: PubMed, the Cochrane Library, Scopus and EBSCO. We are confident that these four search databases would gather pertinent journals within the specified field. A total of 2,936 articles were retrieved through keyword searches across these databases.

Study selection

Following the PRISMA-ScR guidelines, duplicate titles (911 in total) were removed, resulting in 2,025 articles being considered. Upon assessment, 1,942 of these articles were excluded because they were not relevant, were not retrieved ($n=21$), were not-original, such as review articles ($n=2$), were not related (those excluding middle and older adults and irrelevant topics) ($n=50$), were non-English articles ($n=4$). Consequently, only six articles were ultimately deemed suitable for inclusion in the review. Since the reviewers had no significant disagreements and did not recommend any revisions, the form remained unchanged. Two reviewers independently screened the title and abstract of each citation.

Charting the data

All the data selected from the journal databases were organized via Microsoft Excel. The extracted data included the author(s), publication year, country, study design, study population, sample size, methods of evaluating salt perception, cognitive status assessments, key findings, and outcomes. These data are presented in two separate tables in the results section of the review as shown in Fig. 1.

Collating, summarizing and reporting results

Following the framework of Arksey and O'Malley [24], the final stage involved organizing the relevant findings according to the research questions, specifically focusing on salt perception and cognitive impairment in middle-aged and older adults.

Results

Quality assessment

Using the Critical Appraisal Skills Programme (CASP) checklist [25] for qualitative investigations, two authors (A.S., N.F.M.R.) independently evaluated the quality of the included studies; any discrepancy over the final score was settled by discussion and/or an expert showed in Table 3. The included studies were generally of high quality and satisfied the majority of the CASP checklist's requirements. A few studies, however, were given "can't tell" scores for particular factors, like sample size sufficiency or measurement accuracy, suggesting that there is uncertainty in these areas.

Characteristics of the selected studies

In line with the framework [24] and following the specified inclusion criteria, the literature survey identified six relevant studies (outlined in Table 4). The sample sizes exhibited considerable variation, ranging from 92–687 participants, with ages ranging from 50–87 years. These investigations included five cross-sectional studies and a 3-year longitudinal. Geographically, the studies were diverse, with four originating from Japan and one each from Italy and Amsterdam. Participants were recruited from both hospital and community settings.

Assessment of salt taste perception

Salt taste perception was evaluated through different techniques. In this review, four studies employed the whole mouth test (WMT) [26–28], whereas one study utilized both the intraoral dropping method [29] and

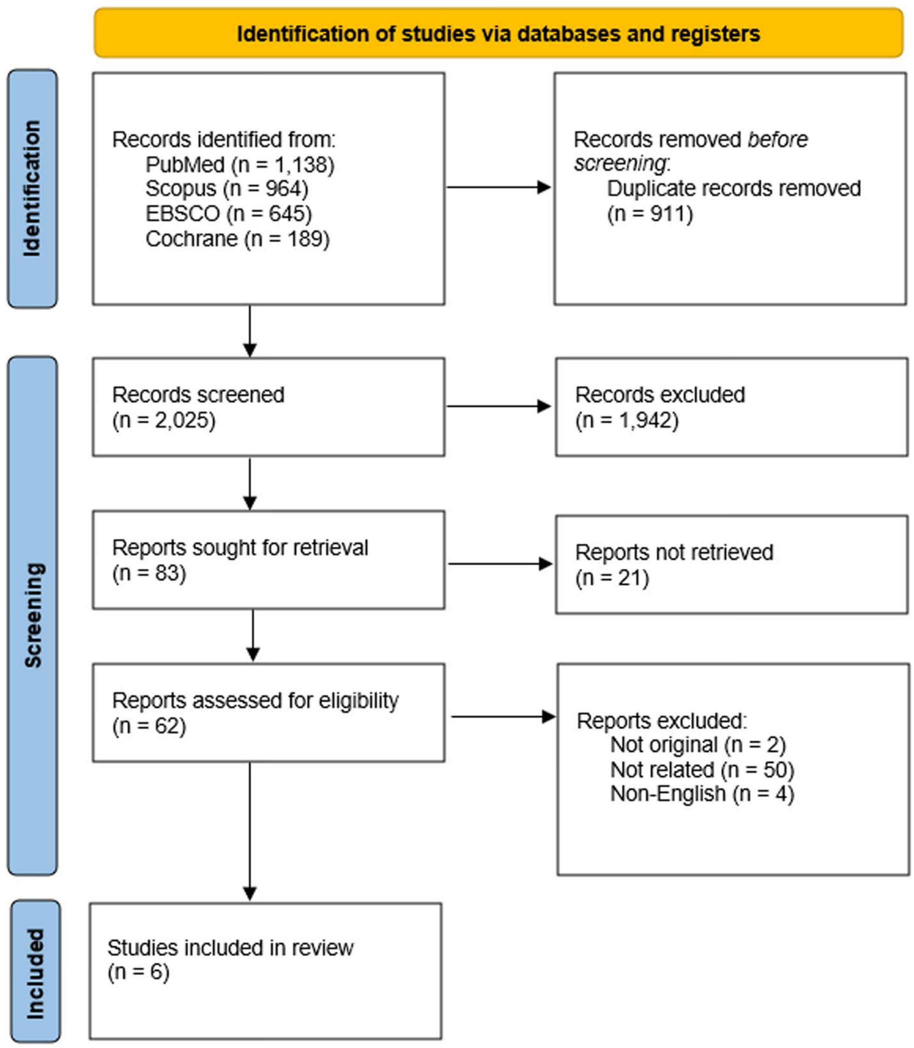


Fig. 1 Flow diagram of study selection

the taste strip test (TST) [31]. Additionally, one study used both the WMT and TST [30] (Table 5). The WMT involves offering each participant 1 ml of sodium chloride solution at room temperature, with concentrations increasing incrementally. The participants hold the solution in their mouth for 3 s to assess the taste before spitting it out. In the intraoral dropping method, a drop of the solution at the lowest concentration is placed into the oral cavity. For the TST, strips are presented in a block-randomized order, starting with the lowest concentration, and placed are on the participants' tongues.

Correct answers set the recognition threshold. If incorrect, the concentration increased in the next trial. Recognizing the lowest concentration earned 1 point, the highest earned 5 points, and failing to recognize the highest earned 6 points [29]. In Doorduijn et al., each correct answer for the basic tastes earned 1 point, with scores ranging from 0 to 4 for each taste [31]. In Kouzuki et al. (2020), detecting the lowest concentration earned 1 point, the highest earned 13 points, and failing to detect the highest earned 14 points. The recognition threshold used the same 1–14 scale [28]. In another study, salt taste was assessed with four other basic tastes, with 1 point for correctly identifying the salt taste [30]. Only two studies classified the salty taste scores into fine and poor taste sensitivity groups, with scores of 1 to 3 indicating fine salt taste sensitivity and scores of 4 or undetected salt taste indicating poor sensitivity [26, 27]. Uota et al. (2016) set the cut-off as such that approximately 75% of the young-old group was classified into the fine-tasting group [26]. Similarly, Ogawa et al. (2017) categorized approximately 70% of participants as having fine taste sensitivity for

Table 3 CASP checklist for included studies

CASP quality appraisal	Study (Year)					
	Uota et al. (2016) [26]	Ogawa et al. (2017) [27]	Kouzuki et al. (2020) [28]	Kouzuki et al. (2018) [29]	Cecchini et al. (2019) [30]	Doorduijn et al. (2020) [31]
1. Did the study address a clearly focused issue?	✓	✓	✓	✓	✓	✓
2. Did the authors use an appropriate method to answer their question?	✓	✓	✓	✓	✓	✓
3. Were the subjects recruited in an acceptable way?	✓	✓	✓	✓	✓	✓
4. Were the measures accurately measured to reduce bias?	✓	✓	?	?	?	✓
5. Were the data collected in a way that addressed the research issue?	✓	✓	✓	✓	?	✓
6. Did the study have enough participants to minimise the play of chance?	✓	✓	?	✓	?	✓
7. How are the results presented and what is the main result?	✓	✓	✓	✓	✓	✓
8. Was the data analysis sufficiently rigorous?	✓	✓	✓	✓	✓	✓
9. Is there a clear statement of findings?	✓	✓	✓	✓	✓	✓
10. Can the results be applied to the local population?	✓	✓	✓	✓	✓	✓
11. How valuable is the research?	✓	✓	✓	✓	✓	✓

CASP Critical Appraisal Skills Programme

follow-up assessments, which helped to differentiate between stable and decreased taste sensitivity groups [27].

Assessment of cognitive function

Various assessments used for cognitive screening include the Montreal Cognitive Assessment (MoCA) [29] and its Japanese version (MoCA-J) [26, 27], the Touch Panel-type Dementia Assessment Scale (TDAS) [28, 29], the Mini-Mental State Examination (MMSE) [29–31] and the Alzheimer's Disease Assessment Scale-cognitive Subscale Japanese version (ADAS-J cog) [29]. Only two studies have assessed cognitive performance via a neuropsychological test battery covering five domains; memory, attention, executive function, language and visuospatial ability [30, 31].

The median MoCA-J score in Ogawa et al. [27] aligns with that of young-old participants and slightly exceeds the median score of old-old participants in Uota et al. (2016) [26]. In the MMSE, scoring a perfect 30 requires answering all questions correctly [30]. Significant differences in MMSE and MoCA scores were found between PD-MCI + and PD-MCI- patients (both $p < 0.001$) by [30], whereas [31] reported disparities in MMSE score control, MCI, and AD dementia groups ($p < 0.001$). The ADAS-J cog and TDAS yield a perfect score of 0 with all answers correct, serving to monitor AD progression. The MMSE, ADAS-J cog, and TDAS scores decreases with progression to MCI and AD [29]. Kouzuki et al. (2020) reported significant differences in TDAS scores between NDC and MCI, between NDC and AD, and between ADD and MCI ($p < 0.05$) [28].

Confounding factors of salt perception

Males with higher rates of smoking and alcohol consumption, and lower education levels, tend to exhibit poorer salt taste sensitivity [26]. Earlier study by Ogawa et al. reported that individuals with fewer teeth, lower salivary flow rates, and a smoking habit also have reduced sensitivity [27]. Additionally, Kouzuki et al. (2018) noted that CSF biomarkers such as p-tau181, Aβ42, and p-tau181/Aβ42 ratio influence salt taste perception [29]. In 2020, Kouzuki et al. noted that age impacts recognition thresholds and that BMI affects detection thresholds, potentially leading to difficulties in taste perception for slender individuals [28]. Additionally, higher education was found positively impacts taste performance, whereas executive dysfunction harms salt taste scores and worsens the identification of salty tastes [30].

Findings on salt perception and cognitive impairment

Among the six studies, three directly reported the relationship between of salt perception and cognitive impairment [26, 27, 29]. The first study, involving 687 participants, categorized them into two groups: young-old and old-old. The participants with a refined taste for salty flavour typically presented higher cognitive scores in both groups. A Mann–Whitney U test revealed that the median (IQR) MoCA-J scores were lower in the poor taste group for salty flavors than in the old-old group,

Table 4 Characteristics of the selected studies

Study (Year)	Country, sample size, study design	Study population	Salt perception evaluation	Cognitive assessment	Outcomes
Uota et al. (2016) [26]	Japan, 1308, cross-sectional study	Based on a cohort study of health and longevity, SONIC 1. Aged 69 to 71 years (young-old group) and aged 79 to 81 years (old-old group) 2. Mean age: Not reported 3. Sex distribution: young-old (372 females, 315 males) and old-old (317 females, 304 males)	WMT	MoCA-J	There is a significant positive relationship between salt taste sensitivity and cognitive scores in both young-old and old-old participants ($p < 0.05$)
Ogawa et al. (2017) [27]	Japan, 621 (baseline) 328 (follow-up), longitudinal study	Based on a cohort study of health and longevity, SONIC 1. Aged 79 to 81 years 2. Mean age: 79.8 ± 0.9 3. Sex distribution: 317 females, 304 males (baseline) and 167 females, 161 males (follow-up)	WMT	MoCA-J	There is a significant positive association between poor salt taste sensitivity and cognitive scores ($p < 0.01$)
Kouzuki et al. (2020) [28]	Japan, 86, cross-sectional study	From the outpatient clinic of Shinsei Hospital, ADD ($n = 29$) or MCI ($n = 43$), and NDCs ($n = 14$) 1. Aged 72 to 87 years 2. Median age: 83 (80-87) (ADD), 79.0 (75-84) (MCI), 74.0 (72-78) (NDC) 3. Sex distribution: 59 females and 27 males	WMT	TDAS	No significant difference was found in salt taste detection and recognition thresholds between the three groups ($p > 0.05$)
Kouzuki et al. (2018) [29]	Japan, 114, cross-sectional study	This study included patients with AD ($n = 40$), MCI ($n = 34$), and HC ($n = 40$) 1. Aged over 70 years 2. Mean age: 79.5 ± 1.5 (AD), 79.2 ± 0.8 (MCI), 76.0 ± 1.1 (HC) 3. Sex distribution: 32 males & 82 females	Intraoral dropping method	MMSE, ADAS-J cog, TDAS	The salty taste score positively correlated with three different cognitive test scores: MMSE and TDAS ($p < 0.05$); ADAS-J-cog ($p < 0.01$)
Cecchini et al. (2019) [30]	Italy, 50, cross-sectional study	PD patients at the Department of Neuroscience, Verona University Hospital 1. Aged over 60 years 2. Mean age: 69.0 ± 10.6 (PD-MCI+), 67.1 ± 10.5 (PD-MCI-) 3. Sex distribution: 21 females and 29 males	WMT, TST	MMSE, MoCA	The salt taste qualities did not significantly differ between PD patients with and without MCI ($p > 0.05$)

Table 4 (continued)

Study (Year)	Country, sample size, study design	Study population	Salt perception evaluation	Cognitive assessment	Outcomes
Doorduijn et al. (2020) [31]	Amsterdam, 92, cross-sectional	Patients of the Amsterdam Dementia Cohort, AD (*n* = 30), MCI (*n* = 22), and controls (*n* = 40) 1. Aged above 50 years 2. Mean age: 62.5 ± 6.8 (Controls), 69.8 ± 7.2 (MCI), 69.5 ± 9.4 (AD dementia) 3. Sex distribution: 44 females and 48 males	TST	MMSE	The salty taste score did not significantly differ among individuals with MCI, controls, and those with AD ($p > 0.05$)

Abbreviations: SONIC Septuagenarians, Octogenarians, Nonagenarians Investigation with Centenarians, *WMT* whole mouth test, *TST* taste strip test, *MoCA-J* Montreal Cognitive Assessment Japanese version, *TDAS* Touch Panel-type Dementia Assessment Scale, *MMSE* Mini-Mental State Examination, *ADAS-J cog* Alzheimer's Disease Assessment Scale–Cognitive Subscale, *MoCA* Montreal Cognitive Assessment, *MCI* mild cognitive impairment, *ADD* Alzheimer's disease dementia, *AD* Alzheimer's disease, *NDC* nondemented controls, *PD* Parkinson's disease, *PD-MCI+* PD patients with MCI, *PD-MCI −* PD patients without MCI

Table 5 Salt perception, cognitive status, confounding factors and outcomes

Study	Salt perception evaluation	Cognitive function/status assessment		Confounding factors	Type of analysis	Results				
		Screening	Tested domains							
Uota et al. (2016) [26]	WMT	MoCA-J	NA	Gender, smoking, alcohol drinking rates, education years	Mann–Whitney's U	MoCA-J score:				
							Median (IQR)			*p*
						Young-old	24 (23–26)	24 (22–25)		0.01
						Old-old	24 (22–26)	23 (21–25)		< 0.01
					Logistic regression	MoCA-J score and salt taste sensitivity:				
							OR (95% CI)			*p*
						Young-old	0.92 (0.85–0.99)			0.02
						Old-old	0.91 (0.85–0.98)			0.01
Ogawa et al. (2017) [27]	WMT	MoCA-J	NA	Number of teeth, salivary flow rate, smoking habit	Mann–Whitney's U	MoCA-J score:				
							Median (IQR)			*p*
						Stable salty taste	24 (22–26)			< 0.01
						Decreased salty taste	23 (21–25)			
					Logistic regression	MoCA-J score and changes in salt taste sensitivity: OR (95% CI): 0.84 (0.76–0.94), $p < 0.01$				
Kouzuki et al. (2020) [28]	WMT	TDAS	NA	Age, BMI	Kruskal–Wallis	Salt detection and recognition threshold:				
							Median (IQR)			*p*
							ADD	MCI	NDC	
						DT	4 (2–5)	3 (2–5)	2 (1–3)	0.075
						RT	7 (6–9)	7 (5.5–8)	6 (6–7)	0.234
						RT-DT	4 (1–6)	3 (2–5)	4 (3–5)	0.620

Table 5 (continued)

Study	Salt perception evaluation	Cognitive function/status assessment		Confounding factors	Type of analysis	Results			
		Screening	Tested domains						
Kouzuki et al. (2018) [29]	Intraoral dropping method	MMSE, ADAS-J cog, TDAS	NA	CSF biomarkers	One-way ANOVA and Tukey's post hoc test	Salty taste score:			
							n	Mean ± SE	
						AD	40	2.7 ± 0.2	
						MCI	34	2.4 ± 0.2	
						HC	40	2.2 ± 0.1	
						Salty taste score comparison:			
							p	95% CI	
						MCI vs HC	1.000	− 0.51 to 0.72	
						MCI vs AD	0.740	− 0.32 to 0.90	
					Pearson's correlation	Salty taste and neuropsychological test			
							r	*p*	
						MMSE	− 0.251	< 0.01	
						ADAS-J cog	0.220	< 0.05	
						TDAS	0.290	< 0.01	
Cecchini et al. (2019) [30]	WMT, TST	MMSE, MoCA	Memory, attention, executive function, visuospatial, language	Education, executive dysfunction	Independent t-test	TST global score salty taste:			
							Mean ± SD	*p*	
						PD-MCI +	2.9 ± 0.8	> 0.05	
						PD-MCI −	3.3 ± 0.9		
						PD-abnormal executive function	2.8 ± 0.8	0.008	
						PD-preserved executive function	3.4 ± 0.8		
Doorduijn et al. (2020) [31]	TST	MMSE	Memory, attention, executive function, visuospatial, language	NR	One-way ANOVA and Bonferroni's post hoc test	Salty taste score, mean ± SE:			
							n	Mean ± SE	*p*
						Controls	40	2.2 ± 0.2	0.572
						MCI	22	2.4 ± 0.3	
						AD dementia	30	2.5 ± 0.2	

Abbreviations: WMT whole mouth test, *TST* taste strip test, *MoCA-J* Montreal Cognitive Assessment Japanese version, *TDAS* Touch Panel-type Dementia Assessment Scale, *MMSE* Mini-Mental State Examination, *ADAS-J cog* Alzheimer's Disease Assessment Scale–Cognitive Subscale, *MoCA* Montreal Cognitive Assessment, *BMI* body mass index, *ADD* Alzheimer's disease dementia, *MCI* mild cognitive impairment, *NA* not available, *NR* not reported, *NDC* nondemented controls, *DT* detection threshold, *RT* recognition threshold, *DT-RT* detection threshold-recognition threshold, *SE* standard error of the mean, *AD* Alzheimer's disease, *HC* healthy controls, *PD* Parkinson's disease, *PD-MCI+* Parkinson's disease with mild cognitive impairment, *PD-MCI−* Parkinson's disease without mild cognitive impairment

23(21–25). Additionally, a multivariate model using logistic regression analysis revealed that the MoCA-J scores were lower in the poor taste group for salty flavour, with odds ratios of 0.92 ($p = 0.02$) for the young-old group and 0.91 ($p = 0.01$) for the old-old group [26].

Next, in a longitudinal study which initially included 621 participants with a score of 328 at follow-up, the median (IQR) of MoCA-J score for those with stable salty taste was 24 (22–26), which was higher than the score of 23 (21–25) for those whose salty taste declined after follow-up. Consequently, those with a stable salty taste were found to have lower salt intake than those with a decreased salty taste. The study also revealed that a significantly greater decrease in MoCA-J scores was associated with decreased salty taste perception (OR = 0.84, $p < 0.01$). These findings suggest that individuals with impaired cognitive function may be at risk for health issues due to inadvertent overconsumption of salty foods, highlighting the importance of careful monitoring of patients with mild or hidden cognitive dysfunction [27].

There were no significant differences in salt taste function among participants with Alzheimer's disease (AD); or MCI and healthy controls. However, the AD participants had the highest mean salty taste score (2.7 ± 0.2) followed by participants with MCI (2.4 ± 0.2) and healthy controls (2.2 ± 0.1). There was a significant positive correlation between salty taste scores and cognitive test results: MMSE ($r = -0.251$, $p < 0.01$), ADAS-J cog ($r = 0.220$, $p < 0.05$), and TDAS ($r = 0.290$, $p < 0.01$). The study emphasized that as Alzheimer's disease progresses, the ability to detect salty tastes diminishes. This may lead to an increase in the amount of seasoning used in food, potentially increasing salt intake [29].

The three other studies focused on comparing difference in salt perception and cognitive performance [28, 30, 31]. According to the Kruskal–Wallis test, 43 MCI patients presented a median (IQR) detection salt taste score of 3 (2–5) points and a salt recognition threshold of 7 (5.5–8) which are higher than those of nondemented controls (NDCs). However, the differences among the three groups, ADD, MCI and NDC in the degree of deviation between the detection and recognition thresholds were not significant ($p > 0.05$). Additionally, only those with MCI (4.7%) failed to recognize the salt taste even at the highest concentration [28]. Doorduijn et al. [31] reported that the mean salty taste score of participants with MCI (2.4 ± 0.3) was higher than that of control (2.2 ± 0.2) participants but slightly lower than that of AD dementia participants (2.5 ± 0.2). However, there were no significant differences ($p > 0.05$) in salt taste perception among the three groups.

Interestingly, one of those studies focused on the Parkinson's disease (PD) population, emphasizing executive function rather than general cognitive impairment [30]. Those authors reported that those without MCI had higher mean TST global scores for salty taste (3.3 ± 0.9) than did those with MCI (2.9 ± 0.8), although the difference in salt taste qualities was not significant. Nonetheless, the TST scores were negatively impacted by executive dysfunction, with patients with impaired executive function showing significantly worse ($p < 0.05$) salty TST global scores than those with intact executive function. This observation highlights a distinct link between executive dysfunction in PD patients and difficulties in recognizing salt taste.

Discussion

As far as we concern, this is the first review of its kind to gather the most recent evidence on the link between salt taste perception and cognitive impairment. In total, three studies [26, 27, 29] found a significant relationship between salt taste sensitivity and cognitive scores, suggesting that being able to perceive salt well may help prevent cognitive impairment, while three additional studies [28, 30, 31] found no notable contrast in salt taste perception and cognitive ability between control participants and those with mild cognitive impairment (MCI).

Generally, the studies with significant associations were cross-sectional studies that could not establish a cause-and-effect relationship or analyse the change in salt taste and cognition over some time. More high-quality longitudinal studies in both healthy adults and high-risk groups across wider cognitive spectra are needed to illuminate and test the mechanism of salt perception and cognitive impairment. On the other hand, even if the study population was of higher risk, the limited spectrum of cognitive function observed in a cross-sectional setting would limit the chances of observing any significant association. In this review, a study included a population of Parkinson's disease (PD) patients [30], who are considered a higher-risk group owing to the common presence of MCI [32, 33], while taste impairment is often an overlooked nonmotor feature of PD. These findings was confirmed previous studies reporting that PD patients had poorer sodium chloride taste identification performance than controls did [18, 34]. However, the control sample was composed of normal controls without cognitive impairment, thus a comparison between PD patients with MCI and controls with MCI was not possible.

Most of the studies in this review utilized the MMSE, MoCA, ADAS-J-cog, and TDAS, which are designed to detect global cognitive impairment. However, the results are based on the overall score and not specific to individual cognitive domains. Investigating the specific domains of cognitive impairment is crucial, as different cognitive domains may be linked to salt perception. Previous studies have indicated that memory load reduces salt taste perception implying that individuals with cognitive impairment in the memory domain may experience similar effects [35, 36]. In this review, only one study reported an association between executive dysfunction and salt perception [30].

Executive dysfunction observed in PD patients with MCI is linked to abnormalities in the prefrontal cortex, which is implicated in taste perception [37, 38]. A recent study by Liu et al. demonstrated that heightened activity in the left dorsolateral prefrontal cortex (DLPFC), known for its role in executive function, correlates with enhanced self-control in food choices and sensitivity to salt taste [39].

Older adults with lower cognitive function have been found to have a reduced threshold for detecting sodium chloride [27]. As a result, decreased taste sensitivity, especially for salt, is frequently seen in patients with cognitive impairment, which is consistent with earlier studies [40, 41]. The ability to detect salty tastes decreases with the progression of AD, potentially leading to increased salt intake due to more seasoning being used in food [29].

To a certain extent, the results of these reviews indicate that individuals with compromised cognitive function could potentially face health risks due to unintended excessive salt intake. A recent study suggested that to counteract the decline in their ability to taste salt, older adults frequently boost their consumption of salty food [42]. This is in line with finding that individuals with decreased salty taste perception had higher salt intake compared to those with stable salty taste perception [27]. An earlier study demonstrated that older individuals had notably lower recognition thresholds for salty taste compared to young adults [43]. Nevertheless, the old-old category participants have lower median salt intake regardless of having fine or poor salt sensitivity than the young-old category participants [26]. This trend is likely due to the higher prevalence of hypertension among older adults. Similarly, other studies have shown that older individuals tend to make more persistent efforts to lower their salt intake compared to younger individuals [44, 45]. However, additional studies investigating salt taste detection and recognition thresholds found no correlation with dietary salt intake, suggesting that preferences and genetic factors such as SLC4A5 and TRPV1 genotype may also play a role in influencing sodium intake [46, 47].

Many studies controlling for variables have examined factors related to both salt taste and cognitive function, such as age, gender, education, smoking, alcohol consumption, salivary flow, and the number of teeth. It was observed that age significantly worsened salt taste scores, but since age did not differ significantly across groups (PD vs. controls, PD-MCI + vs. PD-MCI −), it was not considered a confounder [30]. Similarly, another study reported that taste recognition is linked to age and cognitive function, with cognitive function affecting the recognition threshold rather than the detection threshold [28]. Years of education showed a positive relationship with salt perception in studies by [26] and [30], although this conflicted with [27]. In Cecchini et al. (2019) [30], education levels did not differ across groups, so there was no bias. Males tend to have poorer salt taste sensitivity [26], which is supported by previous studies indicating gender differences in taste sensitivity [48, 49]. Research has shown that smoking reduces salty taste sensitivity [27], while both smoking and alcohol consumption have been associated with taste reduction [26]. A recent study also found that both cigarette smoking and alcohol consumption correlated with salty taste preferences, potentially leading to excessive sodium intake [50].

The global emergence of the novel SARS-CoV-2 and the initial symptoms of COVID-19 have been linked to gustatory dysfunction in approximately 38.2% of cases. A decline in the perception of at least one particular flavor quality was observed by about 60% of those who reported a taste loss, with salty taste being the most prevalent [51]. Other research, however, revealed that salt taste was significantly less impacted than all other tastes, and that Covid19 patients' salty taste threshold was significantly lower than in the previous trial [52, 53]. Future studies ought to explore the causes behind the uneven effects of COVID-19 on salt taste perception, as well as the ways in which SARS-CoV-2 interacts with salt taste receptors and neurological circuits.

The mixed result of the significant relation of salt perception and cognitive impairment may cause by various things. The methodology of the salt taste perception should be taking note of. The usage of salt taste strip in Doorduijn et al. and (2020) [31] and Cecchini et al. (2019) [30] might contribute to the insignificant finding. A taste strip's consistency of salt perception may be affected by the various rates at which it dissolves, which can be influenced by temperature, salivation, and the physical properties of the strip. Different people may experience varying outcomes due to uneven distribution.

The variations in the concentration used may lead to discrepancies in study outcomes. Studies with significant result used a moderate to high range of sodium concentration compared to Kouzuki et al. (2020) [28] which used wider range have included concentrations too low to influence cognitive outcomes.

It is also important to consider the potential influence of demographic differences in salt perception. It is possible that the salt sensitivity of participants in the significant studies aligns with the concentrations used, while the non-significant studies may have tested populations with different sensitivities or used concentrations that were not sufficiently high to reach the sensory threshold for salt perception. As example, study by Doorduijn et al. (2020) [31] used lower concentration of salt than the other three significant studies which might influence the result. However, previous studies have shown that Asians are more likely to exhibit higher salt sensitivity compared to individuals of European or Western origin [54, 55].

Likewise, the uniformity of the results may also be impacted by variations in cognitive evaluation, such as the use of alternative screening instruments or cutoffs, which may be better appropriate for particular target populations and study environments. Some studies evaluate group differences between PD with and without MCI, while others look at associations of salt sensitivity and cognitive scores. The interpretation of the results might as well get impacted by these conceptual differences.

This review offers a thorough and impartial examination of the current literature, employing a broader search strategy to minimize the chance of overlooking pertinent papers. Additionally, validated and standardized measures were utilized to evaluate salt perception and cognitive function/status. Some limitations were identified in this review. Firstly, the authors noted the limited number of articles in this scoping review, reflecting the scarcity of recent findings on salt perception and cognitive impairment over the past decade. Second, some research may be excluded owing to language barriers, which could leave us with some crucial findings. Thirdly, the lack of information on salt intake levels in many studies complicates the ability to observe the association between salt taste, intake, and their relationship with cognitive function. Lastly, drawing firm findings may be made more difficult by the variety of cognitive impairment states that were covered in our analysis, including mild cognitive impairment, Alzheimer's disease, dementia, and Parkinson's disease. Sensory functions, such as the salt taste perception, may be impacted by the unique underlying mechanisms, development trajectories, and symptomatology of each disorder. Therefore, the authors suggested that future research should incorporate multilingual research to explore how salt perception and intake are linked to cognitive impairment in homogenous state of condition of diverse population.

Conclusions

The reviewed studies revealed inconsistent results concerning the relationship between salt perception and cognitive impairment in middle-aged and older adults. The overall evidence is modest, mainly due to variations in study design, analysis, and methods for assessing salt perception and cognitive function. The latest longitudinal studies are required to minimize the effects of lingering confounding variables and reverse causation. Future research should consider socioeconomic status, combining biomarkers as complementary information and include larger as well as diverse populations, especially those with and without risk factors for cognitive impairment, such as hypertension, diabetes, and obesity. These findings will help clarify the mechanisms of the salt taste sensitivity-cognition pathway. Insights from these studies can improve our understanding of salt sensitivity, support salt reduction strategies, and promote better health outcomes, particularly for older adults.

Authors' contributions

A.S. was responsible for data curation, formal analysis, and visualization, while both A.S. and N.F.M.R conducted the investigation. The methodology was developed by A.S., N.F.M.R., and F.H.M., with N.F.M.R. providing supervision. The original draft was written by A.S. and N.F.M.R., and the review and editing were carried out by A.S., N.F.M.R., S.S., N.F.R., H.H., F.H.M., and T.C.O. All authors have read and approved the final version of the manuscript.

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Data availability

All data generated or analyzed during this study are referenced in this published article.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Spence C, Youssef J. Aging and the (chemical) senses: implications for food behaviour amongst elderly consumers. Foods. 2021;10(1):168.
2. Ng K, Woo J, Kwan M, Sea M, Wang A, Lo R, et al. Effect of age and disease on taste perception. J Pain Symptom Manage. 2004;28:28–34.
3. Leal SC, Bittar J, Portugal A, Falcao DP, Faber J, Zanotta P. Medication in elderly people: Its influence on salivary pattern, signs and symptoms of dry mouth. Gerodontology. 2010;27:129–33.
4. Klasser GD, Utsman R, Epstein JB. Taste change associated with a dental procedure: Case report and review of the literature. J Can Dent Assoc. 2008;74:455–61.

5. Imoscopi A, Inelmen EM, Sergi G, Miotto F, Manzato E. Taste loss in the elderly: Epidemiology, causes and consequences. Aging Clin Exp Res. 2012;24:570–9.
6. Su Y, Yuki M, Hirayama K, Sato M, Han T. Denture wearing and malnutrition risk among community-dwelling older adults. Nutrients. 2020;12(1):151.
7. Sergi G, Bano G, Pizzato S, Veronese N, Manzato E. Taste Loss in the Elderly: Possible Implications for Dietary Habits. Crit Rev Food Sci Nutr. 2017;57:3684–9.
8. Doty RL. Age-related deficits in taste and smell. Otolaryngol Clin North Am. 2018;51(4):815–25.
9. Saunders MJ, Yeh CK. Oral health in elderly people. Geriatric nutrition. Burlington, MA: Jones & Bartlett Publishers; 2013. p. 165–210.
10. Wilujeng CS, Rochmah W, Susetyowati S. Perbedaan asupan mikronutrien pada lansia penderita hipertensi esensial yang overweight dan tidak overweight. Jurnal Gizi Klinik Indonesia. 2013;10(1):25–35.
11. Öner C, Dilan Turan R, Telatar B, Yeşildağ Ş, Hergün Ş, Elmacıoğlu F. A pilot study on salt taste sensitivity threshold in Turkish young adults. Anatol J Cardiol. 2016;16(9):731–2.
12. Kim TK, Yong HI, Jung S, Kim HW, Choi YS. Effect of reducing sodium chloride based on the sensory properties of meat products and the improvement strategies employed: A review. Journal of Animal Science and Technology. 2021;63(4):725.
13. Azinge EC, Sofola OA, Silva BO. Relationship between salt intake, salt-taste threshold and blood pressure in Nigerians. West Afr J Med. 2011;30(5):373–6.
14. Veček NN, Mucalo L, Dragun R, Miličević T, Pribisalić A, Patarčić I, Hayward C, Polašek O, Kolčić I. The association between salt taste perception, mediterranean diet and metabolic syndrome: A cross-sectional study. Nutrients. 2020;12(4):1164.
15. Santisteban MM, Iadecola C. Hypertension, dietary salt and cognitive impairment. J Cereb Blood Flow Metab. 2018;38(12):2112–28.
16. Strazzullo P, D'Elia L, Kandala NB, Cappuccio FP. Salt intake, stroke, and cardiovascular disease: Meta-analysis of prospective studies. BMJ. 2009;339:b4567.
17. Csukly G, Sirály E, Fodor Z, Horváth A, Salacz P, Hidasi Z, Szabó Á. The differentiation of amnestic type MCI from the non-amnestic types by structural MRI. Frontiers in aging neuroscience. 2016;8:52.
18. Doty RL, Nsoesie MT, Chung I, Osman A, Pawasarat I, Caulfield J, Hurtig H, Silas J, Dubroff J, Duda JE, Ying GS, Tekeli H, Leon-Sarmiento FE. Taste function in early stage treated and untreated Parkinson's disease. J Neurol. 2015;262:547–57.
19. Malek Rivan NF, Shahar S, Fakhruddin NN, You YX, Che Din N, Rajikan R. The effect of dietary patterns on mild cognitive impairment and dementia incidence among community-dwelling older adults. Front Nutr. 2022;9: 901750.
20. Liu W, Xing S, Wei F, Yao Y, Zhang H, Li YC, Liu Z. Excessive dietary salt intake exacerbates cognitive impairment progression and increases dementia risk in older adults. J Am Med Dir Assoc. 2023;24(1):125–9.
21. Chugh G, Asghar M, Patki G, Bohat R, Jafri F, Allam F, et al. A high-salt diet further impairs age-associated declines in cognitive, behavioral, and cardiovascular functions in male Fischer brown Norway rats. J Nutr. 2013;143(9):1406–13.
22. Sun F, Zhang JY, Zhao LP, Jin Q, Jin C, Wang QX, et al. Age differences in the impact of dietary salt on metabolism, blood pressure and cognitive function in male rats. Food Funct. 2024;15(2):689–703.
23. McGrattan AM, Stephan BC, Shannon OM, Mazidi M, Gilchrist M, Smallwood M, et al. Independent and interactive associations of dietary nitrate and salt intake with blood pressure and cognitive function: a cross-sectional analysis in the InCHIANTI study. Int J Food Sci Nutr. 2022;73(4):491–502.
24. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. Int J Soc Res Methodol. 2005;8(1):19–32.
25. Critical Appraisal Skills Programme (CASP). CASP (For Descriptive/Cross-Sectional Studies) Checklist [Internet]. 2023. Available from: https://casp-uk.net/casp-tools-checklists/. Accessed 2 Jan 2025.
26. Uota M, Ogawa T, Ikebe K, Arai Y, Kamide K, Gondo Y, et al. Factors related to taste sensitivity in elderly: Cross-sectional findings from SONIC study. J Oral Rehabil. 2016;43(12):943–52.
27. Ogawa T, Uota M, Ikebe K, Arai Y, Kamide K, Gondo Y, et al. Longitudinal study of factors affecting taste sense decline in old-old individuals. J Oral Rehabil. 2017;44(1):22–9.
28. Kouzuki M, Ichikawa J, Shirasagi D, Katsube F, Kobashi Y, Matsumoto H, et al. Detection and recognition thresholds for five basic tastes in patients with mild cognitive impairment and Alzheimer's disease dementia. BMC Neurol. 2020;20:1–11.
29. Kouzuki M, Suzuki T, Nagano M, Nakamura S, Katsumata Y, Takamura A, et al. Comparison of olfactory and gustatory disorders in Alzheimer's disease. Neurol Sci. 2018;39:321–8.
30. Cecchini MP, Federico A, Zanini A, Mantovani E, Masala C, Tinazzi M, et al. Olfaction and taste in Parkinson's disease: the association with mild cognitive impairment and the single cognitive domain dysfunction. J Neural Transm (Vienna). 2019;126:585–95.
31. Doorduijn AS, De Van Der Schueren MAE, van de Rest O, De Leeuw FA, Fieldhouse JLP, Kester MI, et al. Olfactory and gustatory functioning and food preferences of patients with Alzheimer's disease and mild cognitive impairment compared to controls: the NUDAD project. J Neurol. 2020;267:144–52.
32. Weil RS, Costantini AA, Schrag AE. Mild cognitive impairment in Parkinson's disease—what is it? Curr Neurol Neurosci Rep. 2018;18:1–1.
33. Cammisuli DM, Cammisuli SM, Fusi J, Franzoni F, Pruneti C. Parkinson's disease–mild cognitive impairment (PD-MCI): A useful summary of update knowledge. Frontiers in aging neuroscience. 2019;8(11):303.
34. Jagota P, Chotechuang N, Anan C, Kitjawijit T, Boonla C, Bhidayasiri R. Umami and other taste perceptions in patients with Parkinson's disease. Journal of Movement Disorders. 2022;15(2):115.
35. van der Wal RC, van Dillen LF. Leaving a flat taste in your mouth: task load reduces taste perception. Psychol Sci. 2013;24(7):1277–84.
36. Liang P, Jiang J, Ding Q, Tang X, Roy S. Memory load influences taste sensitivities. Front Psychol. 2018;9:2533.
37. Cecchini MP, Fasano A, Boschi F, Osculati F, Tinazzi M. Taste in Parkinson's disease. J Neurol. 2015;262:806–13.
38. de Bondt CC, Gerrits NJ, Veltman DJ, Berendse HW, van den Heuvel OA, van der Werf YD. Reduced task-related functional connectivity during a set-shifting task in unmedicated early-stage Parkinson's disease patients. BMC Neurosci. 2016;17:20.
39. Liu KC, Joseph PV, Feldman DE, Kroll DS, Burns JA, Manza P, Volkow ND, Wang GJ. Brain imaging of taste perception in obesity: a review. Curr Nutr Rep. 2019;8(2):108–19.
40. Cooper RM, Bilash I, Zubek JP. The effect of age on taste sensitivity. J Gerontol. 1959;14(1):56–8.
41. Weiffenbach JM, Baum BJ, Burghauser R. Taste thresholds: quality specific variation with human aging. J Gerontol. 1982;37(3):372–7.
42. Sato H, Wada H, Matsumoto H, et al. Differences in dynamic perception of salty taste intensity between young and older adults. Sci Rep. 2022;12:7558.
43. Yoshinaka M, Ikebe K, Uota M, Ogawa T, Okada T, Inomata C, et al. Age and sex differences in the taste sensitivity of young adult, young-old and old-old Japanese. Geriatr Gerontol Int. 2016;16:1281–8.
44. Vega-Vega O, Fonseca-Correa JI, Mendoza-De la Garza A, Rincón-Pedrero R, Espinosa-Cuevas A, Baeza-Arias Y. Contemporary dietary intake: too much sodium, not enough potassium, yet sufficient iodine: the SALMEX cohort results. Nutrients. 2018;10(7):816.
45. Aubakirova M, Sultanov M, Izimov A, Sakko Y, Bex T, Mussagazin A, et al. Factors influencing salt-reducing behavior in young adults: a pilot cross-sectional study from Kazakhstan. Cent Asian J Glob Health. 2020;9(1). https://doi.org/10.5195/cajgh.2020.415.
46. Pilic L, Mavrommatis Y. Genetic predisposition to salt-sensitive normotension and its effects on salt taste perception and intake. Br J Nutr. 2018;120(7):721–31.
47. Pilic L, Lubasinski NJ, Berk M, Ward D, Graham CA, Anastacio VD, et al. The associations between genetics, salt taste perception and salt intake in young adults. Food Qual Prefer. 2020;84:103954.
48. Alia S, Aquilanti L, Pugnaloni S, Di Paolo A, Rappelli G, Vignini A. The influence of age and oral health on taste perception in older adults: A case-control study. Nutrients. 2021;13(11):4166.
49. Braun T, Doerr JM, Peters L, Viard M, Reuter I, Prosiegel M, et al. Age-related changes in oral sensitivity, taste and smell. Sci Rep. 2022;12(1):1533.
50. Ma J, Lee YK. The effects of cigarette smoking and alcohol drinking on salty taste preferences based on Korean Community Health Survey data. Nurs Res Pract. 2023;17(3):487–502.

51. Parma V, Ohla K, Veldhuizen MG, Niv MY, Kelly CE, Bakke AJ, Cooper KW, Bouysset C, Pirastu N, Dibattista M, et al. More than smell—COVID-19 is associated with severe impairment of smell, taste, and chemesthesis. Chem Senses. 2020;45(7):609–22.
52. Catton G, Gardner A. COVID-19-induced taste dysfunction and recovery: association with smell dysfunction and oral health behaviour. Medicina. 2022;58(6):715.
53. Asadi MM, Shankayi Z, Bahrami F, Mohammadzadeh T, Amini H, Naderi M. Quantitative analysis of taste disorder in COVID-19 patients, the hyper-sensitivity to salty quality. New Microbes New Infect. 2021;43: 100919.
54. Loo G, Puar T, Foo R, Ong TK, Wang TD, Nguyen QN, Chin CT, Chin CWL. Unique characteristics of Asians with hypertension: what is known and what can be done? J Hypertens. 2024;42(9):1482–9.
55. Elijovich F, Weinberger MH, Anderson CA, Appel LJ, Bursztyn M, Cook NR, Laffer CL. Salt sensitivity of blood pressure: a scientific statement from the American Heart Association. Hypertension. 2016;68(3):e7–46.

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