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Sensory stimulation of taste and smell in older adults: a literature review

Estimulação sensorial do paladar e do olfato em idosos: uma revisão de literatura

Estimulación sensorial del gusto y el olfato en adultos mayores: una revisión de la literatura

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The article is original because it addresses an issue that, in addition to being relevant due to population aging, is also a topic with a low number of studies in the so-called global south.

ABSTRACT

The sensory stimulation of smell and taste are very important. Now is the time to pay more attention to it, since its correct functionality is essential for life, health and safety of people, especially in old age. At this stage, is when these senses are deteriorating, possibly due to decreased production of receptor cells. Therefore, the objective of this article is to identify existing methods for sensory stimulation, physiology and evaluation of the chemo-sensory senses: taste, smell and everything that contributes to the knowledge, approach and intervention of these senses. Documentary design was applied, with reference review in databases such as: MEDLINE, LILACS, SciELO, Springer, Elsevier, EBSCO and Google Scholar. Descriptors in Health Sciences (DeCS) were used: Aged, Taste perception, Sense of Smell, Sensation. The search included the languages: English, Portuguese and Spanish. The references have been published in the last 6 years. That is, from 2017 to 2022, 30 articles were included since they met the inclusion and exclusion criteria. The results obtained were: identification of physiology, evaluation methods, diagnosis, and stimulation. They have been implemented and have been shown to be suitable for exploring, analyzing and improving functionality. In conclusion, diagnostic tests and sensory stimulation methods are suitable for application in elderly people.

Keywords: Older adult. Taste. Smell. Sensory function.

RESUMO

A estimulação sensorial do olfacto e do paladar são muito importantes. E agora é o momento de lhes dar mais atenção, já que a sua correcta funcionalidade é fundamental para a vida, saúde e segurança das pessoas, especialmente na velhice. Nesta fase é em que estes sentidos estão a deteriorar-se, possivelmente devido a uma diminuição da produção de células receptoras. Portanto, o objectivo deste artigo é identificar os métodos existentes de estimulação sensorial, fisiologia e avaliação dos sentidos quimiosensoriais: gosto, olfacto e tudo o que contribui para o conhecimento, abordagem e intervenção destes sentidos. Com a aplicação do desenho documental, com revisão de bibliografias, em bases de dados como: MEDLINE, LILACS, SciELO, Springer, Elsevier, EBSCO e Google Scholar, utilizando Descritores em Ciências da Saúde (DeCS): Envelhecimento, Percepção do Gosto, Senso do Olfacto, Sensação. Foram utilizados os Descritores em Ciências da Saúde (DeCS): Idoso, Percepção do paladar, Olfato, Sensação. A busca incluiu os idiomas: inglês, português e espanhol. As referências foram publicadas nos últimos 6 anos. Ou seja, de 2017 a 2022, foram incluídos 30 artigos sendo que eles cumprem aos critérios de inclusão e exclusão. Os resultados obtidos foram: identificação da fisiologia, métodos de avaliação, diagnóstico e estimulação. Eles foram implementados e mostraram-se adequados para explorar, analisar e melhorar a funcionalidade. Em conclusão, testes diagnósticos e métodos de estimulação sensorial são adequados para aplicação em idosos.

Palavras-chave: idoso; técnicas de exercício e de movimento, velocidade de caminhada; terapia por exercício.

RESUMEN

La estimulación sensorial del olfato y el gusto son muy importantes. Y ahora es el momento de prestarles más atención, ya que su correcto funcionamiento es fundamental para la vida, la salud y la seguridad de las personas, especialmente en la vejez. Es entonces cuando estos sentidos se deterioran, posiblemente debido a una disminución en la producción de células receptoras. Por tanto, el objetivo de este artículo es identificar los métodos existentes de estimulación sensorial, fisiología y evaluación de los sentidos quimiosensoriales: gusto, olfato y todo lo que contribuya al conocimiento, abordaje e intervención de estos sentidos. Con la aplicación de diseño documental, con revisión de bibliografías, en bases de datos como: MEDLINE, LILACS, SciELO, Springer, Elsevier, EBSCO y Google Scholar, utilizando Descriptores en Ciencias de la Salud (DeCS): Envejecimiento, Percepción del Gusto, Sentido del Olfato, Sensación. Se utilizaron los Descriptores de Ciencias de la Salud (DeCS): Adulto Mayor, Percepción del Gusto, Olfato, Sensación. La búsqueda incluyó los siguientes idiomas: inglés, portugués y español. Se publicaron referencias en los últimos 6 años. Es decir, del 2017 al 2022 se incluyeron 30 artículos que cumplieron con los criterios de inclusión y exclusión. Los resultados obtenidos fueron: identificación de la fisiología, métodos de evaluación, diagnóstico y estimulación. Se implementaron y demostraron ser adecuados para explorar, analizar y mejorar la funcionalidad. En conclusión, las pruebas diagnósticas y los métodos de estimulación sensorial son adecuados para su aplicación en personas mayores.

Palabras clave: ancianos, ejercitar técnicas de movimiento; la velocidad al caminar; terapia de ejercicio.

INTRODUCTION

Over the years, the ability to perceive through the chemical senses (taste and smell) decrease. That means that there is deterioration with aging, especially after the age of 60 (Bigman, 2020). These changes are probably attributed to the reduction and/or dysfunction in the renewal of receptor cells (Högerle, 2019) (Sergi et al., 2017). Regarding olfactory impairment or decrease in older adults, when it occurs gradually, it has been called presbyosmia. With this concept used appropriately, it would help to establish differences among disorders. It usually occurs in neurodegenerative diseases (Delgado et al., 2020). Regarding taste, the investigations carried out show dysfunction in basic flavors. Sensitivity to acid or sour and bitter is the most affected (Delgado et al., 2020).

The different disorders are detailed in Table 1. We found the particularity that in taste, most of the dysfunctions are mainly attributed to the failure of the olfactory sense (Obiefuna & Donohoe, 2022) (Doty, 2019). In the prevalence of these disorders, unanimity has not been found This is because in each country and population there are different data, due to the diversity of tests applied. However, it was found that there is a higher prevalence of affectation in older people than in young people. And more in men than in women (Doty, 2019a). Here is the justification for the implementation of sensory stimulation of taste and smell in older adults. It seeks thereby the preservation of their functions.

Table 1 *Classification of senses disorders: taste and smell*

DISORDERS	SMELL	TASTE
Quantitative	Hyperosmia (Increased sense of smell)	Hypergeusia (Increased sense of taste)
	Normosmia (normal olfaction)	Normogeusia (normal taste)
	Hyposmia (Decreased sense of smell)	Hypogeusia (decreased taste ability)
	Anosmia Functional (Low residual capacity in everyday life) Complete (No detectable residual odor)	Ageusia (Complete loss of taste)
Qualitative	Parosmia (altered perception of odors in response to a stimulus)	Parageusia (altered perception of flavors before a stimulus)
	Phantosmia (Perception of odors in the absence of a stimulus)	Phantogeusia (Impression of taste in the absence of stimulus)
	Olfactory intolerance (excessive or reduced subjective sensitivity)	

Source: (Högerle, 2019)

In elderlies, changes of aging are aggravated by the use of medications, dentures, etc., due to the decrease in mucin and calcium. These influence the decrease in saliva, increasing the ionic concentration (Rupel et al., 2021) and affect both the oral coating and the perception of flavors (Sergi et al., 2017). All these aspects, in the long run, influence the sensory and textural perception of food, leading to a decrease in its intake and therefore to poor nutrition. (Xu et al., 2019).

The nutritional status of the PAM is related to the senses of taste and smell. They are very important when choosing the food to eat. For this reason, they require considerable attention (Kershaw & Mattes, 2018). Depending on the type of food that people eat, is the proportion of vitamins (thiamine, Vitamin D, Vitamin C, folic acid, etc.), minerals (iron, Zinc, phosphorus, etc.) and other components that benefit or harm nutrition. This could lead to a deficit or excess, ending up in nutritional disorders (Jeon et al., 2021).

These aspects of the senses of smell and taste have often been left aside and overlooked. Hence the importance, innovation, relevance of the evaluation of these senses. The application of sensory stimulation strategies aims at preserving or improving functionality. It will also help the intake of food, which contribute to an optimal nutritional status of the PAM. With the application of sensory stimulation of taste and smell, maintaining or improving their functionality is sought.

THEORETICAL FOUNDATION

Background review

Velasco J, in his doctoral thesis in Alicante in 2018, with the title **"Program for sensory stimulation of taste and smell for Alzheimer's patients: GYMSEN Project",** carried out a program dating back to 2013, in order to stimulate the senses of smell and taste. It also aim at recovering interest in food and maintaining sensory capacities in older adults from three different groups. 1. People over 55 years of age without sensory impairment, 2. People who regularly attended university classrooms of Experience, at Miguel Hernández University; 3. Institutionalized people from the Italian NGO dedicated to social management and projects focused on the elderly. And Alzheimer's patients from the Greek non-profit

organization Athens Association of Patients with Alzheimer and Related Disorders. They used both qualitative and quantitative methodology, with the application of the sensory training program. It lasted 3 months. The activities were organized in 24 sessions (twice a week for 12 weeks) The duration of each session varied between 1 and 1.5 hours. Finally, they concluded that the program is beneficial, focusing on two fundamental aspects: improvement in sensory function and therefore in nutritional status (Velasco Navarro Juan Francisco & Collado Enrique Roche, 2017).

Guaneros M et. al, carried out his review article in Mexico in 2020, **"Smell Alterations in Obesity".** Its objective was to relate the perception of food with obesity, since there has been little investigated on the topic. It included review and reading methodology of 100 scientifically-based articles: Pub med, Scielo, Redalyc and Science direct. It concluded that the current evidence indicates that the sense of smell is altered in obese population. And that it is necessary to do research on whether it is a general decrease, as indicated in some studies, or if perception is increased for some stimuli (eg, stimuli of high caloric value) and decreased for others (eg, stimuli not associated with food) (Guarneros et al., 2020).

Pugnaloni S. et al., in 2020 with their article **"Modifications of taste sensitivity in cancer patients: a method for the evaluations of dysgeusia",** had the objective to analyze taste alterations in the patient population. It compared with healthy controls and considered the gender. It sought to prevent and/or reduce taste disturbances and malnutrition in people with cancer. Forty-five cancer patients undergoing chemotherapy intervened and were compared with thirty-two healthy controls. They used the taste function test to determine the taste sensitivity with different concentrations, including the four basic tastes (salty, sweet, sour, bitter) They included fat and water. They concluded that coping strategies should be provided in the face of subjective taste impairment. Alterations in taste sensitivity influence food preferences and appetite. Therefore, clinicians could have the potential to support changes in dietary intake. And, consequently, in the nutritional status of patients by adopting appropriate appetizing strategies and, based on this, modifying their eating habits (Pugnaloni et al., 2020).

Higgins M. and Hayes J. in their research carried out in Pennsylvania in 2019, **"Regional variation of bitter taste and aftertaste in humans",** had the objective to explore regional differences in the perceived intensity of bitter stimuli in the regions of the oral cavity in 2 experiments. In the first experiment they used a whole mouth slurp and spit procedure and in the second experiment a spatial taste test using cotton swabs. Data collection was done at the Penn State Sensory Evaluation Center, in semi-insulated test booths. After the research, they concluded that bitter stimuli vary in perceived intensity at various locations in the oral cavity through the observation of intensity differences in both a spatial taste test and a slurp and spit protocol. Bitter stimuli also differ in terms of temporal perception, as some stimuli tend to linger while others decay much more rapidly after reaching the same maximum intensity. (Higgins & Hayes, 2019).

Hurtado K. in his Thesis carried out in 2020 Alicante, **"The flavors of food and nutrition in elderly people. Gender analysis",** had the purpose to analyze the scientific evidence available on the differences according to sex and gender in the taste and smell of food in older adults. These should be taken into consideration to offer adequate nutritional care. It took place through the reference review of original articles in the MedLine database in the last 10 years. Languages: Spanish and English. Search keywords: "Taste and sex-differences", "Elderly and taste disorders and sex differences", with the inclusion criteria: articles that analyzed taste in the elderly, by gender and type of neurodegenerative disease. After the scientific review, he concluded that there are differences according to sex in the elderly population where men have a lower perception of taste. On the other hand, women presented more olfactory alterations and consequently taste alterations. This situation worsened with neurodegenerative diseases and affected the nutritional status of the elderly. In most of the studies, the gender perspective was not included in the taste analysis. Taking this into account, better nutritional care and prevention could be offered to healthy and sick elderly people (Hurtado Soria Karen Alejandra & Ruiz Cantero María Teresa, 2020).

Kershaw J. and Mattes R, in their review article carried out in the United States, in 2018, **"Nutrition and taste and smell dysfunction**", searched for scientific articles, in scientific bases: Pub med, Scielo, Redalyc, Science direct, with the objective of verifying if sensory stimulation influences the selection and metabolism of food. Their study used a review methodology and scientific reading of 130 articles. They concluded that taste and smell play an important role in the selection of diet and metabolism, taking into account culture, environment and exposure (Kershaw & Mattes, 2018).

Alia S et al., in 2021 in the article **"The influence of age and oral health on taste perception in older adults: A case-control study**", established the objective of investigating the effect of age and oral condition on discrimination of taste in two different groups of elderly subjects living in an Italian residential institution or in the community. A total of 90 subjects were enrolled in the study. They performed the evaluation using the two-color mixability test. Taste function was assessed using cotton pads soaked with six taste stimuli (salty, sour, sweet, bitter, oily, and water). They concluded with a positive correlation between age and teeth and a negative correlation between age and masticatory mode. In addition, they determined significant differences in the sensitivity to bitter taste between subjects who used removable and non-removable prostheses. Significant gender differences and between males were identified in the two samples (Alia et al., 2021).

Melis M. et al., in 2019 carried out the investigation and publication of the article **"TAS2R38 bitter taste receptor**

and attainment of exceptional longevity", with the aim of evaluating the role of the bitter receptor TAS2R38 in the achievement of longevity. It has been widely associated with individual differences in taste perception, food preferences, diet, nutrition, immune responses, and pathophysiological mechanisms. It also focused on determining differences in genotype distribution and haplotype frequency in the TAS2R38 gene among a cohort of centenarians and near centenarians and two control cohorts. They concluded, based on their data that provide evidence for an association between genetic variants of the TAS2R38 gene and human longevity, that the TAS2R38 bitter receptor may be involved in the molecular physiological mechanisms involved in the biological process of aging. It suggests that individuals who have a pair of functional alleles (PAV/PAV) in the TAS2R38 gene may have a favorable genetic condition to achieve exceptional longevity (Melis et al., 2019).

Delgado M. et. al, in the year 2020, the article, **"Spanish validation for olfactory function testing using the sniffin' sticks olfactory test: Threshold, discrimination, and identification",** was carried out to validate the test in a Spanish sample. This study included 209 healthy normosmic male and female volunteers, ranging in age from 20 to 79 years. Of this group, 22 participants were retested for evidence of test-retest reliability. Odor familiarity for descriptors in the olfactory identification test was also studied in an independent healthy sample. Required cultural modifications were applied. The full version of the Sniffin' Sticks Olfactory Test (TDI) was administered to an initial group of 242 participants aged between 18 and 79 years. These participants came from social networks, advertisements in public places (such as universities, libraries and contact with private companies) and from the Central Hospital of the Red Cross (Madrid, Spain). The evaluations were carried out between July 2020 and September 2020. The results were that men and women, as well as smokers and non-smokers, performed equally in all the tests. However, significant differences were found between the age groups in each score. The general trend is that the olfactory function progressively decreases with age, with the elderly group (+60 years) showing the lowest scores. In conclusion, these normative data, in addition to the cultural modifications of the test, make it possible to apply the Sniffin' Sticks Olfactory Test in the Spanish population (Delgado-Losada et al., 2020).

Oleszkiewicz a. et al., in their article carried out in Europe in 2018, **"Updated Sniffin' Sticks normative data based on an extended sample of 9139 subjects",** had the objective to provide updated and detailed normative data based on a large-scale sample. It helped increase diagnostic validity by reference to narrow age groups, as previous normative values were based on smaller sample sizes, especially in the older group of subjects. They obtained data from 9139 healthy subjects (4928 women of 5-96 years and 4211 men of 5-91 years old), to whom they applied the standard "Sniffin' Sticks" test. It includes the threshold (T), discrimination (D) and identification (I) subtests, which yields a total TDI score. For the interpretation of results, hyposmia with a TDI score below 30.75 was established. They observed age-related changes in each area, higher in the case of thresholds. Individuals between 20 and 30 years of age obtained the best results, while

Delgado M- et al., in 2021 in Spain, carried out the article **"Development of the Spanish version of sniffin' sticks olfactory identification test: Normative data and validity of parallel measures** children under 10 years of age and adults over 71 years of age obtained only half the score. They reached the conclusions, based on data provided, that there is guidance to assess individual olfactory performance in relation to specific age groups. There are significant effects of gender and age, with a higher increase in olfactory test scores between 5 and 20 years of age and a drastic decline between the ages of 60 and 71 (Oleszkiewicz et al., 2019). **",** with the aim of developing the Spanish version of the Sniffin' Sticks Olfactory Identification Test and of obtaining normative values for the Spanish population, with free parameters. They conclude that there is subjective intensity of the odorants. The influence of possible demographic covariates such as sex, age, smoking or educational level are analyzed, and the items that best discriminate are studied. Additionally, they perform a cultural adaptation of the violet version. For this, three independent samples of normosmic healthy volunteers were studied with the objective of obtaining normative values. The sample was 417 participants (18-89 years old) (Delgado-Losada et al., 2021).

METHODS

A descriptive review article was carried out. It included the application of documentary design and review of references in databases such as: MEDLINE, Redalyc, LILACS, SciELO, Springer, Elsevier, EBSCO and Google Scholar. Descriptors in Health Sciences (DeCS): Aged, Taste perception, Sense of Smell, Sensation were used. These were included in the languages: English, Portuguese and Spanish. They were published in the last 6 years, that is, from 2017 to 2022, 30 articles were reviewed because they met the inclusion and exclusion criteria (Figure 1). This process was carried out in order to collect and analyze data on the senses of taste, smell, functionality, tests for their evaluation and existing sensory stimulation methods

Figure 1. Systematic Review. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097.

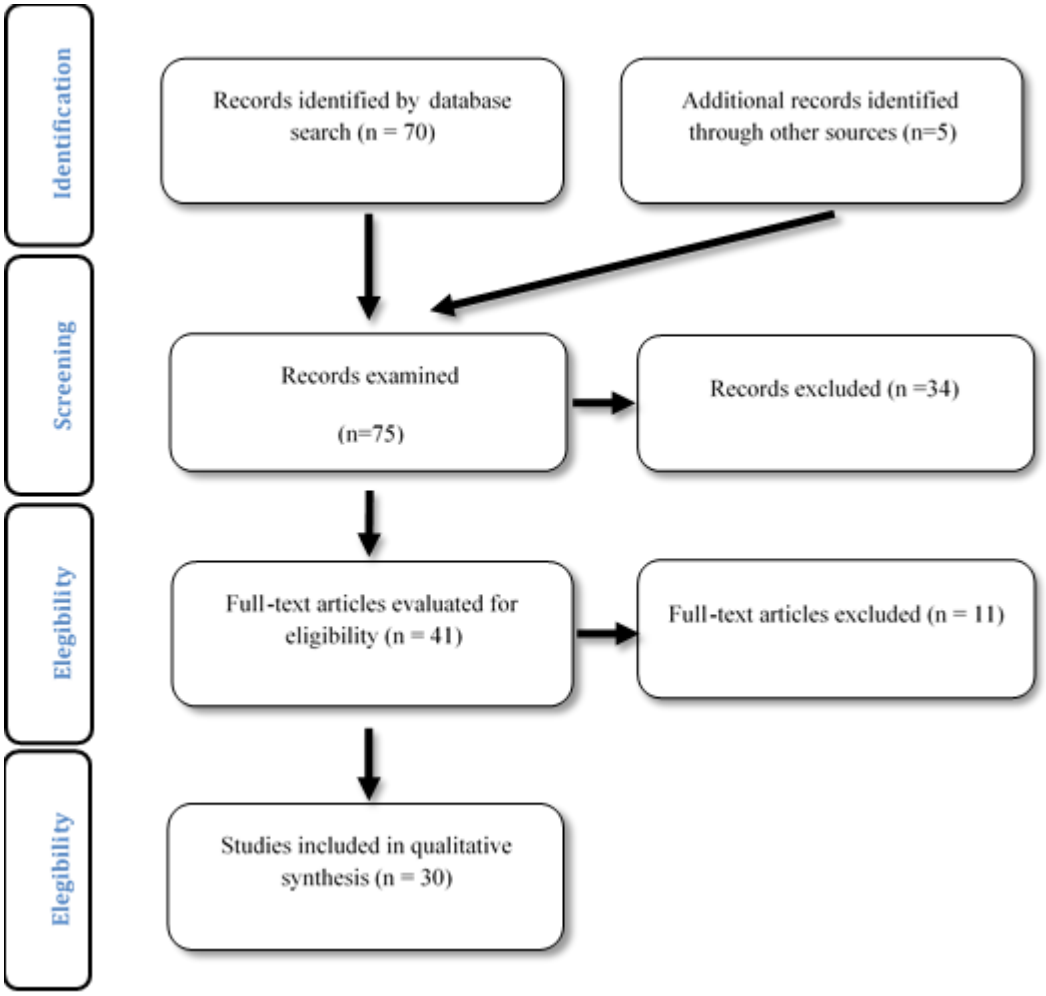

Table 2 Scientific articles selected for review

Authors	Country	Type	Title of article	General Objective	Results
Bigman Galya (2020)	EE. UU	Original	Age-related Smell and Taste Impairments and Vitamin D Associations in the U.S. Adults National Health and Nutrition Examination Survey.	To examine the associations between vitamin D (VD) deficiency and smell and taste disturbances in adults aged 40 to 80 years.	The study showed that Vitamin D probably plays an important role in the senses of smell and taste, due to the discovery of the significant association it has with existing deficiency in people over 70 to 80 years of age. Out of the participants in their study, approximately 20 %, presented vitamin D deficiency.
Delgado et al. (2020)	Spain	Review	Analysis of alterations in the senses of taste and smell in older adults: a review of the literature.	To update the existing knowledge about the alterations of the taste and smell senses, during aging.	After reviewing 37 articles, they conclude that both taste and smell decrease with age, especially after 65 years of age. This may be due to reduced renewal of taste and smell receptors, or also by pharmacological treatments derived from chronic or acute diseases that can occur with age.
Turner J. H. (2020)	Germany	Review	Olfactory training: what is the evidence?	Incorporate a fundamental treatment for olfactory disorders both in clinics specialized in smell and taste and in general otorhinolaryngology practices.	Data suggest that olfactory training could potentially improve olfactory function. And that if there is a combination of interventions it may be superior, as suggested by a small number of studies that combine olfactory training with systemic or topical corticosteroids.
Hogerle (2019)	Germany	Review	Riech-und Geschmacksstörungen haben gravierende Folgen [Smell and taste dysfunction in the elderly population - what the general practitioner needs to know.	To review the chemosensory functions of smell, taste and the disorders, with the consequences, that they bring in old age.	In old age, the decrease in chemosensory senses could lead to weight gain or loss, social isolation, depression; even dangerous situations could arise due to the dysfunction.
Kershaw y Mattes (2018)	USA	Review	Nutrition and taste and smell dysfunction	To discuss how sensory stimulation influences food selection and metabolism; And how to relate these aspects to the dysfunction of smell and taste.	The sensory ability of taste and smell do play an important role in the selection of diet and metabolism. However, the context of other factors such as environment, exposure, and culture must be considered.
Veneri et al. (2021)	Italy	Review	Taste sensitivity in healthy adults:gustatory test validation and observational study.	To establish a diagnostic and standardized tool, available for use in clinical practice and evaluation of healthy adults.	Considering the identification threshold and flavor intensity, they apply the test to 72 participants, with whom the test itself was validated. They used the four main flavors with four different concentrations, for their identification.
Catamo et al. (2021)	Italy	Original	Differences in taste and smell perception between type 2 diabetes mellitus patients and healthy controls.	To evaluate the perception of taste and smell in patients with Diabetes Mellitus 2 (DM2) and healthy controls.	In the study, hypogeusia and hyposmia prevailed in the majority of T2DM participants, compared to healthy control participants. It suggests a possible neurodegenerative complication of diabetes.
Delgado et al. (2021)	Switzerland	Original	Development of the Spanish Version of Sniffin' Sticks Olfactory Identification Test: Normative Data and Validity of Parallel Measures.	To develop the Spanish version of the Sniffin' Sticks Olfactory Identification Test and obtain normative values for the Spanish population. Also to validate the internal structure of the blue and purple versions as a parallel measure, carrying out a cultural adaptation, abbreviated to the purple version.]	They found differences in the results as age increases, especially from 60 years of age. They concluded that Test sniffin' sticks is the appropriate tool for olfactory evaluation, providing the extraction of seven items with which it could be used as an abbreviated test in the blue version. They provide additional evidence of validity of the internal structure of the 2 versions (blue and purple).
Huang et al. (2021)	China	Original	Reliability of whole-mouth taste test in assessment of gustatory function in healthy adults	To assess the test-retest reliability of taste function using whole-mouth taste tests in healthy adults.	With an ICC=0.7 they conclude that the whole-mouth test is a reliable method for subjective taste function since it has good test-retest reliability in the evaluation of subjective taste function in healthy adults.
Sodal et al. (2021)	Norway	Original	Smell, taste and trigeminal disorders in a 65-year-old population.	To investigate the prevalence of disorders of smell, taste, trigeminal nerve and associated factors in the 65-year-old population in Oslo, Norway.	Revelation that out of the 65-year-old population, a third have altered smell. More than a quarter have impaired taste, while the perceptual decrease in smell and taste is more common than in women.
Guarneros et al (2020)	Mexico	Review	Smell disorders in obesity	To review the literature on the relationship between the sense of smell and obesity.	Based on current evidence, it indicates that the sense of smell is impaired in the obese population. They point out that further research should be conducted as this is a promising area for further study.
Balungwe et al. (2020)	Africa	Original	Adaptation of the Sniffin' Sticks Test in South-Kivu	To evaluate the applicability of the Sniffin' Sticks test in the population of South Kivu (DR Congo), and	The culturally adapted version of the Sniffin' Sticks test for the South Kivu population was established with changes in 5 odors due to having shown difficulty in recognizing them. In the identification test; they also conclude

				develop a culturally adapted version with normative values.	that there was no significant impact of age on identification.
Barragán et al. (2018)	Spain	Original	Bitter, Sweet, Salty, Sour and Umami Taste Perception Decreases with Age: Sex-Specific Analysis, Modulation by Genetic Variants and Taste-Preference Associations in 18 to 80 Year-Old Subjects.	To analyze the influence of age on the assessment of the intensity of the five basic flavors: sweet, salty, bitter, sour and umami (separately and together in a "total taste score") and its modulation by sex and genetics in a relatively healthy population (men and women) aged 18 to 80 years.	They found a great variety of perception of the 5 basic flavors. They confirmed that as age advances, there is a decrease in taste perception, mainly in bitter and acid flavors. They also detected differences in taste dysfunction according to sex, with the male sex being more affected.
Huang et al. (2022)	China	Original	Normative data on the subjective gustatory function of Chinese adults	To evaluate the gustatory function of healthy Chinese adults with the whole-mouth test based on five basic tastes, including umami taste.	They obtained a significant negative correlation with age, according to the total score of taste recognition because the age group from 51 to 65 years presented the lowest scores, and they also suggest that the full mouth test is simple, reliable and quick application.
Norgaard et al. (2021)	Dinamarca	Original	Differences in Correlation between Subjective and Measured Olfactory and Gustatory Dysfunctions after Initial Ear, Nose and Throat Evaluation	To assess the taste function of healthy Chinese adults with the whole-mouth test based on five basic tastes, including umami taste.	The taste function is poorly related to the measurable. Thus it also reflects olfactory dysfunction. While on the contrary the subjective olfactory dysfunction was positively correlated with the measurable. Out of the 602 research participants, 50% showed normal taste functions and subjective alterations of the smell. 98% classified their measurable olfactory function as absent, plus only 64% were anosmic. Therefore, it is advisable to carry out validated chemo-sensory tests, since they could help to guarantee more accurate diagnosis and timely treatment.
Doty & Potter (2021)	USA	Original	Validation of the Waterless Empirical Taste Test (WETT®)	To describe and validate the new Waterless Empirical Taste Test (WETT®) within a clinical population. It is portable and does not require liquid flavorings or liquid rinses.	They demonstrated that the Waterless Empirical Taste Test (WETT®) can be as reliable and sensitive as it exhibited comparable sensitivity. Even in some cases it was higher than two comparison taste tests: whole mouth taste test and the most traditional flavor quadrant taste test that are liquid based.
Von et al. (2019)	Germany	Original	Impact of taste and smell training on taste disorders during chemotherapy – TASTE trial	To improve taste disorders through taste and smell training.	Out of the operated patients, taste improved significantly, from baseline (median taste strips: 7.0 points) to week 12 (median taste strips: 10.0 points). The group without intervention who completed the reassessment did not show changes. Therefore, they conclude that intensified nutritional counseling with taste and smell training can improve taste perception in patients receiving chemotherapy.
Fjaeldstad et al. (2018)	Denmark	Original	Re-Test Reliability of Gustatory Testing and Introduction of the Sensitive Taste-Drop-Test	To introduce a sensitive taste-drop test, which uses a simple gradual increase in concentration, and compare the reliability of the repeat test of Taste-Strips taste-drop test.	The Sensitive-Taste-Drop-Test had a higher retest reliability for the 4 flavors: sweet, salt, sour and bitter. It had a greater internal consistency (Alpha of Cronbach: Sweet, 0.88; Salty, 0.83; Sour, 0.86; Bitter, 0.85).
Pieruzzini R. (2020)	Venezuela	Original	To propose a taste test adapted to the Venezuelan population	Proposal for a taste test adapted to the Venezuelan population.	The proposed taste test turned out to be an easy, practical, reliable and safe. More than evaluating taste disorders, it helps us to discern the capacity for taste discrimination in a thorough and effective way. It uses substances known to the Venezuelan population.
Gago, A. S., & Pieruzzini, R. (2020)	Venezuela	Original	Olfactory rehabilitation vs multisensory rehabilitation in patients with anosmia	To compare the effectiveness of treatment with olfactory rehabilitation vs multisensory rehabilitation in patients with anosmia from the neurology clinic, of the otorhinolaryngology department of the Military University Hospital "Dr. Carlos Arvelo"	Both rehabilitation modalities were effective in our study. However, multisensory rehabilitation is a more effective tool in the treatment of patients with olfactory disorders.
Besser (2020)	Germany	Original	Flavor education and training in olfactory dysfunction a pilot study	To implement flavor education (FE) in people with olfactory dysfunction (OD) and encourage these patients to experience flavors in terms of a favor training (FT).	Taste education appears to be feasible, appreciated, and welcome in the clinical setting, and may be a welcome second-line therapy in patients with olfactory dysfunction. This study shows beneficial trends in FT. However, more studies with larger sample sizes and standardized training protocols are needed.
Doty (2019)	USA	Review	Treatments for disorders of smell and taste: a critical review	To explore numerous investigations and their details described in the literature to treat and handle taste and smell disorders with primary focus on findings supported by critical, empirical evidence.	Evidence for the efficacy of more than two dozen putative treatments for taste and smell disorders was reviewed. Among the most publicized treatments are "olfactory training", theophylline, vitamin A, vitamin B-12 and zinc sulfate.
Pedraza & Lévano (2021)	Peru	Review	Taste disturbances as an indicator of systemic disease	To update existing theories about the physiology of taste, early and timely detection of different systemic or metabolic diseases such as diabetes mellitus, hypertension, and Covid-2019	Taste disorders are an indicator in diseases such as: type II diabetes mellitus, arterial hypertension, Alzheimer's disease, cancer, among others. They cause a psychological impact on those who suffer from it. This affects their quality of life at the level of their tongues. Receptors that detect sweet, salty, sour, bitter and umami flavors have been studied, but even these data are limited.
Jeon et al. (2021)	Korea	Original	Taste Sensitivity of Elderly People Is Associated with Quality of Life and Inadequate dietary Intake	To investigate the types of taste disturbances in Korean elders and the factors associated with the taste disturbance in relation to dietary intake and other factors.	We performed correlation and regression analyses. The findings suggest that age is correlated with the taste recognition threshold. It was related to high levels of four flavors where the exception was bitter taste.
Andrade et al. (2021)	Mexico	Review	Smell and taste disorders, from the basis to clinical practice	To show healthcare personnel the way and importance of exploring the senses of smell and taste, their treatment and rehabilitation options.	The way of approaching smell and taste disorders was shown. It included the importance of the prevalence of these disorders and their impact as a prognostic marker in various diseases. The knowledge and application of evaluation strategies should be medically mastered.
Delgado et al. (2020)	Spain	Review	Spanish Validation for Olfactory Function Testing Using the Sniffin' Sticks Olfactory Test: Threshold, Discrimination, and Identification	To validate the Sniffin Sticks test in a Spanish sample.	They validated the familiarity with the smell of the descriptors in the Sniffin Sticks olfactory identification test and applied the required cultural modifications, with the respective test-reset. It found significant differences based on age.
Oleszkiewicz et al. (2019)	Germany	Original	Updated Sniffin' Sticks normative data based on an extended sample Of 9139 subjects	To provide updated, detailed, and normative data according to the large-scale sample, in order to increase diagnostic validity by age groups, especially in the group of older people.	The large sample has allowed groups of 10 years to be categorized. It obtained homogeneous results, which facilitated a detailed understanding of olfactory performance in the course of life. The total score of the TDI was between 1 and 48, with 30.75, being the normosmia cut-off value in young adults.
Sergi et al. (2017)	English	Review	Taste Loss in the Elderly: Possible Implications for Dietary Habits.	To analyze changes in taste perception related to age, and indications in food preferences.	Ageusia can affect food preferences, although dietary habits appear to be more influenced by other factors such as social and psychological.
Bernardita et al. (2017)	Chile	Review	Diagnosis in pathology of smell: Literature review.	To establish available diagnostic tools in clinical practice for the study of smell.	Tests such as: UPSIT (Smell Identification Test), Sniffin Stick test, have been established. They are of choice due to costs and ease of execution, despite the fact that they have limitations to apply to children and people with neurological or psychiatric disorders
Delgado et al. (2021)	Cuba	Review	Smell disorders	To update the clinical-therapeutic performance of disorders of the smell.	Chemosensory functions decrease with age. Aging, thus affects the abilities of old people and impacts on their quality of life. Loss of smell worsens even more so in dementia and in some cases precedes the onset of cognitive deterioration.

Source: Authors based on retrieved literature

RESULTS AND DISCUSSION

The act of perceiving taste is called taste and the act of perceiving odors is called olfaction. The taste capacity is closely linked to the olfactory capacity. In cases of dysfunction it is believed that most presentations of taste dysfunction are due to smell damage (Obiefuna & Donohoe, 2022) (Nørgaard & Fjaeldstad, 2021).

Physiology of the chemical senses: taste and smell

In the older adult population, a third have altered smell. More than a quarter present taste impairment. Dysfunction, in these two senses, is more common in women than in men (Sodal et al., 2021). On the other hand, the sense of taste indicates that men are more affected and mainly in the perception of bitter and acid flavors (Barragán et al., 2018) (Sergi et al., 2017a). In addition, in the case of taste, it can be used as an indicator in early and timely detection of diseases such as Type II Diabetes Mellitus, Arterial Hypertension, Alzheimer's disease, Cancer, Covid-19, among others (Jeon et al., 2021). They have evidenced hypogeusia and hyposmia in Type II Diabetes Mellitus. This prevailed in the majority, which suggests that this may be due to a possible neurodegenerative complication (Catamo et al., 2021) (Delgado et al., 2021).

The use of drugs for the treatment of diseases, which appear as age advances and the decrease in the renewal of the receptor cells of the stimuli, are attributed to cause the appearance of alterations, in the senses of taste and smell, especially from the age of 65 (Delgado Olea et al., 2020) (Delgado-Losada et al., 2020). The decrease in these chemosensory senses can lead to: social isolation, depression or even deadly situations due to the non-perception of odors, flavors of damaged, toxic or flammable food such as household gas (Högerle, 2019). This can also cause nutritional disorders such as malnutrition and obesity. Obese population has shown impaired sense of smell (Guarneros et al., 2020).

Diagnosis and evaluation of taste and smell

Within the tests to carry out the diagnosis and evaluation of the chemosensory senses, we find a great variety of names with a similar procedure: Reliable taste test in subjective function and reliable in test-retest (Huang et al., 2021). It includes four primary flavors at four increasing concentrations in each flavor, with which the identification threshold and intensity are obtained (Veneri et al., 2021). It is evident that older adults have a recognition threshold, in higher concentrations than in young adults (Jeon et al., 2021) (Huang et al., 2021). Other types of existing reliable and sensitive tests that do not require flavoring liquids or rinsing are the Waterless Empirical Taste Test (WETT), which uses cellulose pads (Doty et al., 2015). Taste Drop Test showed, in all four flavors, an alpha Cronbach's 0.88 sweet, 0.86 sour, 0.85 bitter, and 0.83 salty (Fjaeldstad et al., 2018). An adaptation of the taste test was found for the Venezuelan population, which was called easy, practical, reliable and safe. They carried it out with ten flavors (coconut, chocolate, peanut, grape, tail, coffee, tangerine, cinnamon, vanilla, and pineapple). These all flavors are substances known to the Venezuelan population (Pieruzzini 2020).

In the smell tests, several studies use similar tests. Among them we have sniffin sticks which consists of three components (threshold (T), discrimination (D), and identification (I)), with which the total score (TDI) is obtained (Balungwe et al., 2020) (Oleszkiewicz et al., 2019). It was originally created in Germany and validated with cultural adaptations in various countries, including the Spanish population (Delgado et al., 2021), in which normative data have been established. (Delgado-Losada et al., 2021)

Sensory stimulation as a treatment for smell and taste disorders.

The investigations suggest deepening in the implementation of sensory stimulation because it is a non-invasive and safe procedure. Thus, positive and statistically significant effects have been observed (Sorokowska et al., 2017). Some of them found a possible relationship with nutritional supplements, vitamins and minerals (Jeon et al., 2021). They show that by improving vitamin D deficiency, it could contribute to mitigating the chemosensory loss of smell, age-related taste among adults (Bigman, 2020) However, more evidence is required in experimental research on separate stimulation of smell and taste. Likewise, more studies on stimulation of the two senses that are closely linked in their functionality should be done (Turner 2020).

Smell training is suggested to be done from two to three times a day, for at least three months. It should include a representative in the fragrance categories: floral (rose), resinous (eucalyptus), fruity (lemon), spicy or aromatic (clove) (Fernández et al., 2021). They seem to improve olfactory disorders even in neurodegenerative diseases (Högerle 2019) (Doty, 2019). Another intervention for the training of taste and smell are: juices and foods of different flavors that should be tested blindfolded. This should be done for at least 15 min twice a week. The patients should smell the essence or aromatic species of lemon and cloves for 15 seconds two times a day, for 12 weeks, preferably in the morning and at night (Von et al. 2019).

Another form of intervention was: 50 favors of common ingredients, various spices, fruits and herbs. They were chosen according to ease and availability. During the training period, subjects were instructed to consciously experience all the favors ("with all the senses") from the list on separate days, especially those in which they were interested. Given a 16-week training period, time was provided to try a flavor from the 50 favor list every other day and complete a short questionnaire about each experience (Besser et al., 2020).

CONCLUSION

Stimulation strategies for smell and taste are, specifically, the daily exposure to smells and flavors, preferably twice a day. They can be in the morning and at night, in a period of 12 weeks. After this period of time, the functionality should be evaluated. Quantitative tests for "smell" type (Test Sniffing Sticks) and for "taste" type (taste Trops) will be used. By doing this, it will be possible to compare the functionality before and after the application of the strategies of stimulation of smell and taste.

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