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Are there relationships between basic tastes, age, gender and nutritional status in an elderly population?

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Abstract

Due to a rise in number of elderly in the general population and their difficulties to feed themselves properly, a characterization of their sensibility to basic tastes could help to comprehend palatability and help overall nutritional counseling. The objectives of this study were to characterize the detection thresholds of the basic tastes in an elderly population regarding age, gender and nutritional status. The Threshold Sensibility test has been applied to detection of sweet, salt, sour, bitter and umami basic tastes, using six different concentrations. Were applied the Mini Mental State Examination test, the Mini Nutritional Assessment and Body Mass Index calculation. The sample has been classified accordingly to the variable distribution rate and analyzed with a non-parametrical statistical method. Two hundred and eighty elderlies participated, between 60 and 97 years old, mostly females and overweight. MMSE evaluated according to schooling presenting the majority of the studied population normality and regarding the MNA 18% had any risk of malnutrition. The highest percentage of perception was for monosodium glutamate at least once in the solution offered. Findings pointed toward more preserved taste detection to salt and umami in this population and that there is no statistical power to relate basic tastes sensibility to gender or nutritional status. On an overall analysis, sensibility to sweet, salt and umami tastes get worse as they grow older regardless of gender. Changes in habits according to age should be further explored, may improve food acceptance and quality of meals consumed.

Keywords: Taste detection; Threshold; Elderly; Nutritional status

1. Introduction

The global population aged 60 or older totalized 962 million in 2017, which means that it has more than doubled the estimated number from the early 1980s. This number is expected to double again until 2050 when it is predicted to rise almost to 2.1 billion. For The United Nations the elderly population aged 80 and over will probably rise to more than the triple between 2017 and 2050 from 137 to 425 million. [1]

Different kinds of diseases and feeding difficulties from many sources could cause impairment in the quality of their diet as well as in its balance, leading to malnutrition. The aging process itself will offer limitations in selection and ingestion of certain foods and will contribute to chewing process impairment as well as the loss of taste: Dysgeusia [2], and decreased taste perception. [3]

The palate is defined as the capacity to recognize taste which is the response to the five basic stimuli: sweet (represented in this work through sucrose), salt (sodium chloride), sour (citric acid), bitter (caffeine) and umami (monosodium glutamate). The later known as the fifth basic taste is stimulated by substances as sodium glutamate and 5-

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ribonucleotides (as Inosinate and Guanylate) are naturally found in meat, fish, vegetables, and dairy products. Umami has the power to expand and enhance other tastes. [4,5]

The elderly will carry sensorial and digestive tract modifications such as chewing impairment, salivary production, and oral mucosa integrity disturbances. They will also be prone to less sensibility to thirst and to several side effects of drug treatments that will also cause interference in their feeding patterns. [6]

Due to the rise in the number of elderly in the general population and to multiple interferences in food intake in this particular group, knowledge about thresholds to basic tastes may help to better comprehend food intake behavior and contribute to more reliable dietary counseling minimalizing damages from the otherwise wrong nourishing process.

The objective of this research was to characterize the basic tastes detection thresholds and their relation to nutritional status, gender and age in an elderly population.

2. Methods

The current research is a transversal study of a population of 280 patients over 60 years old that frequently visit elderly clinics. The diseases presented by the elderly were categorized into systems: cardiovascular, neurological, musculoskeletal, endocrine.

The Mini-Mental State Examination [MMSE] test was applied to evaluate cognition and those who scored less than 24 points, leading to suspicion in cognitive status, were excluded. This test, described by Folstein et al [7] is one of the most widely used tests to assess cognitive function and raises suspicion of dementia cases. [8, 9]

For the weight determination, under a +/- 0.1kg precision, just one scale has been selected. Against a Frankfurt plan scale [10], height was measured with the patient touching the scale with the backside of head, back, gluteus, ankles, and calf. The Body Mass Index [BMI] was calculated by dividing weight (kg) by squared height (m). The classification of nutritional status was performed according to Lipschitz [11] and nutritional status according to the Brazilian Food and Nutritional Surveillance System.[12]

The Mini Nutritional Assessment [MNA – Nestlé] has been used to identify elderly patients poorly nourished or under risk of malnutrition, as it is a simpler and quicker way to those diagnoses. [13, 14]

For sensorial analysis, the Threshold Test has been applied for all the 5 basic tastes, individually, in a silent room, with no scents, under pleasant temperature, and natural illumination [15]. All the solution samples were made at Albert Einstein Hospital Laboratories in Sao Paulo Brazil, using deionized water prepared with Direct-Q 3 UV with plump deionizer from Millipore and Mettler Toledo's analytical scale for solute quantification. All the concentrations used were preconized by the International Organization for Standardization [16] in grams per liter (g/l) order to determine sweet with sucrose, salt with sodium chloride, sour with citric acid, and bitter with caffeine. Concentrations for monosodium glutamate were adapted from those presented by MOJET et al. [17, 18]

Table 1 Solutes concentrations to threshold test performance in the elderly (N=280)

Solutes concentrations g/L	Sucrose	Sodium chloride	Citric acid	Caffeine	Monosodium glutamate
1°	0.500	0.090	0.004	0.025	0.49
2°	1.000	0.180	0.008	0.050	0.79
3°	2.000	0.370	0.015	0.100	1.25
4°	4.000	0.750	0.030	0.200	1.99
5°	8.000	1.500	0.062	0.400	3.15
6°	16.000	3.000	0.125	0.800	4.98

Samples were presented to the patients in pairs (pure deionized water paired to a prepared solution for a given taste test). Each patient would taste six different solutions with increased concentrations of the solute and should refer to the

researcher if in any of these solutions would be possible to detect any taste. In that way, one would be offered plain deionized water that should be compared to a given solution each and every time another solution was tasted. Presentation and tasting of the solutions were performed until the elderly were able to detect any stimuli twice in a row when the test was finished.

This research was submitted and approved by the Ethics Committee in all fields where this study took place. Patients who were enrolled signed a term of free and informed consent according to rules found in 196th Brazilian National Health Council resolution. The research was also approved by the Brazilian Platform of thesis and dissertations (CAAE 49306815.0.0000.0071), by São Paulo Mayor's office and the project management system of the Albert Einstein Hospital Research Institute. The Project was also registered at the ClinicalTrials.gov (Protocol Registration and Results System – PRS). NCT: 03196440. Unique Protocol ID: 49306815.0.0000.0071.

Inclusion criteria: an individual with feeding capability only by oral route and with full capacity to express themselves in order to go through taste sensibility tests. Excluding Criteria: Elderly with acute clinical conditions such as fever, respiratory viruses, and oral lesions, and with less than 24 points in the MMS test.

Statistical analysis: the sample was characterized by the distribution rate of the variables. The analysis between variables has been performed through Friedman's test and multiple non-parametric comparisons for paired data. Non-parametric tests were used for Threshold analysis and Mann-Whitney's test for age, gender, and nutritional status. The elderly were distributed in groups as follows: less than 70 years old (yo), 70 - 79 yo, 80 - 89 yo and over 90 yo. Kruskal-Wallis test was applied to study the relationship between thresholds and BMI.

3. Results

The analyzed sample was comprised of 280 elderly between 60 and 97 years old. Clinical characteristics regarding age, gender, nutritional status, and cognition are listed in table 2.

Table 2 Sample characteristics regarding age, gender, nutritional status and cognition.

Variable		Frequencies	%
Gender	Male	100	35.7
	Female	180	64.3
Age	< 70 yo	63	22.5
	70 a 79 yo	108	38.5
Cognition (MMSE)	Normal	144	51.4
	Not normal	136	48.6
Nutritional status (MNA)	With risk	51	18.2
	Without risk	229	81.8
BMI	Low weight	23	8.2
	Eutrophic	97	34.6
	Overweight	160	57.1
Total		280	100.0

In relation to the thresholds of detection of the basic tastes, it was observed that there was detection in all solutions offered. The distribution observed in table 3, shows that the highest percentage (86%) of perception was for monosodium glutamate at least once in the solution offered, followed by the salty taste (50%). In addition, most of the elderly detected intermediate and low concentrations in the sweet and sour tastes.

Table 3 Distribution of detection thresholds for basic tastes.

Variable	n	%
Threshold sweet		
At least one in the first	107	38.2
Intermediate	158	56.4
At least one in the last	15	5.4
Threshold salty		
At least one in the first	140	50.0
Intermediate	131	46.8
At least one in the last	9	3.2
Threshold sour		
At least one in the first	128	45.7
Intermediate	140	50.0
At least one in the last	12	4.3
Threshold bitter		
At least one in the first	121	43.2
Intermediate	133	47.5
At least one in the last	26	9.3
Threshold umami		
At least one in the first	242	86.4
Intermediate	36	12.9
At least one in the last	2	0.7
Total	280	100.0

The analysis of basic tastes, sweet, salty, sour, and bitter, shows that for salty taste there was a notable difference among the participants. Salty taste is more preserved, that is, about 50% of the elderly needed less solute to identify this taste, recognizing the threshold in the first solutions presented.

Table 4 Rank of perception values of Threshold basic tastes

Threshold	Average	DP	Median	Minimum	Maximum	P
Sweet	18,208 ^{a*}	24,48	6,63	3,13	100,00	<0,001
Salty	10,6274 ^b	18,30	4,00	3,00	100,00	
Sour	13,7257 ^a	22,20	4,80	3,20	100,00	
Bitter	20,9536 ^a	30,63	4,38	3,13	100,00	

Test of Friedman; Multiple non-parametric comparisons for paired *Averages followed by the same letter in the same column do not show significant difference. N=280

No difference was observed between sexes when it came to the detection of thresholds of basic tastes, there was no interference in the detection of basic tastes ($p>0.05$). Only for salty taste, the medians were 0.130 for females and 0,110g/L for males. For the other tastes, sweet, sour, bitter, and umami, the median values were the same for both genders.

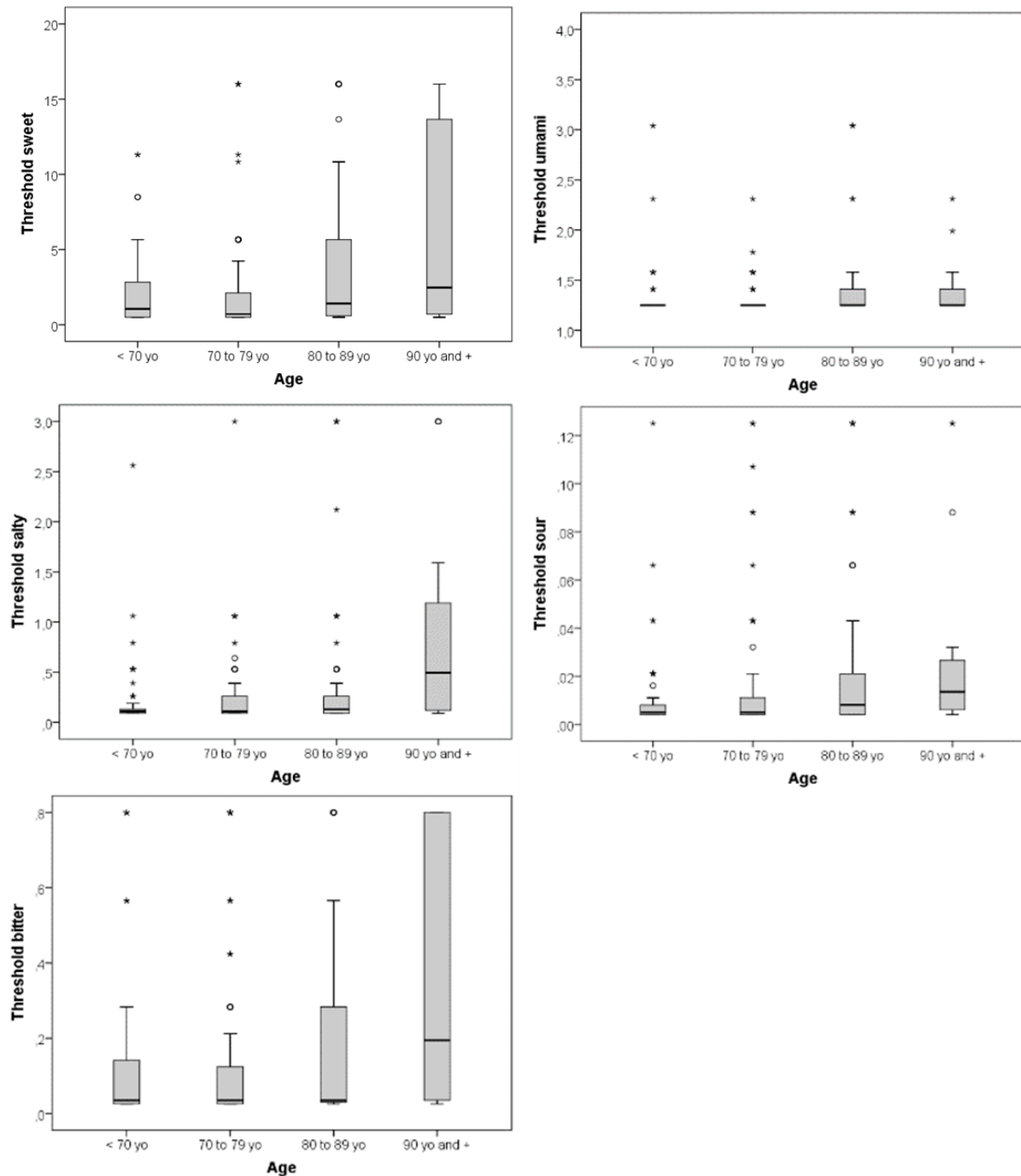


Figure 1 Analysis of threshold values for detection of basic tastes in relation to age group.

The distribution is presented in Figure 1 shows the values of the detection of basic tastes in relation to age group. According to the results, there was a statistically significant difference between sweet, salty, and umami tastes. For these tastes, the amplitude between the perceived concentrations was lower for the elderly under 70. Thus, age presented a statistical difference, in general, an increase in the mean solute concentration detected.

The detection of basic tastes in relation to the nutritional risk did not present statistical differences, and the values of the medians in relation to the sweetest taste are higher for the elderly with nutritional risk. For sour and umami tastes, the median values were the same for the elderly with and without nutritional risk. (Figure 2)

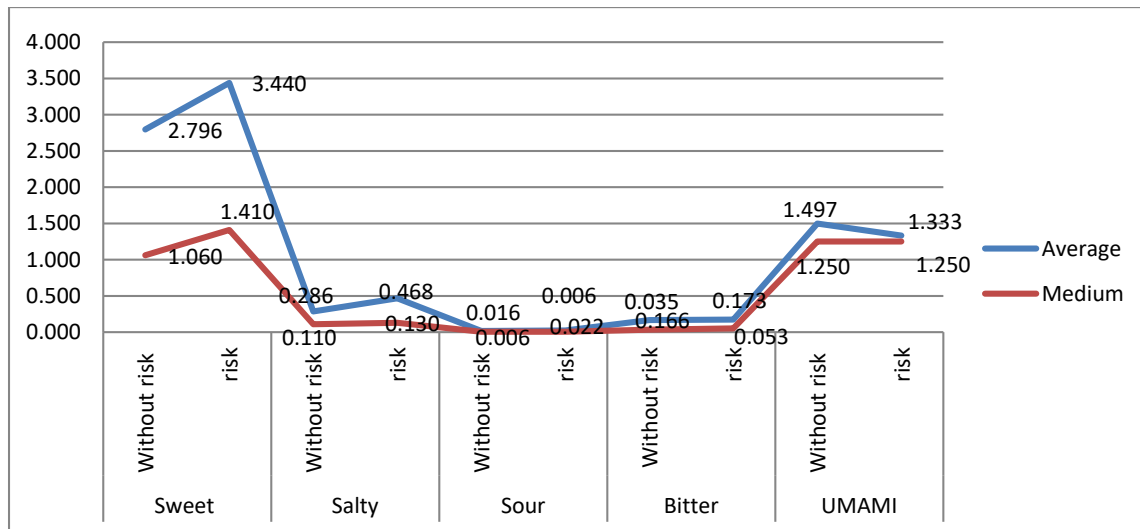


Figure 2 Distribution nutritional Risk and Threshold basic tastes

Regarding nutritional status (classification by BMI), there was no statistical difference in the detection of basic tastes. For the sour and umami tastes, the values were the same for all nutritional states. For sweet, the elderly eutrophic group needed more for detection (1.410), while underweight and overweight needed 1.060g/L. For salty taste, those who presented overweight required less amount of solute (0.110 in relation to 0.130g/L, for underweight and eutrophic). For the bitter, the underweight elderly needed a greater amount of solute (0.053 in relation to the eutrophic ones and overweight 0.035g/L).

4. Discussion

Regarding the studied population, the majority of the patients were female, a result that coincides with the data from the PNAD/IBGE 2017 [21], in which women are the majority in the population aged 60 or older, with 16.9 million (56% of the elderly), while the elderly men are 13.3 million (44% of the group). In the anthropometric evaluation, the majority of the elderly did not present a risk in relation to the nutritional status. This is consistent with the results of a recent study, which evidenced an increase in the prevalence of overweight and obesity and a decrease in underweight among elderly Brazilians 60 or older, of both genders, in the period from 2002/3 to 2008/9, reinforcing the occurrence of the nutritional transition in Brazil [22]. Nutritional status and gender also had no significant association in the detection of basic tastes, a fact that corroborates with Neumann's study. [23]

The MNA test identifies the risk of bad nutrition before any changes in body weight or the levels of serum protein. This index takes into consideration not only weight variation, general and subjective assessment, and quality of diet, but also the BMI. This can be observed among participants that were at risk, even with adequate body weight, but with an inadequate diet. Influenced by their sensory perception the elderly people generally eat what they like, and their food choices might be influenced by the quality of diet.

In a Vanderwee study et al [24] based on MNA, it was observed that 76% of all elderly patients that were hospitalized, suffered from malnutrition and risk of malnutrition, 24.2% were well-nourished patients. Higher values than these searches with outpatient care elderly when 18% have the nutritional risk. Such fact shows how important evaluations are for this age group because during this period the oscillation in nutritional status is quite large.

Other factors also influence the diet and in the gustatory function like the presence of comorbidities and numerous drugs such as antihypertensive. [3,25]. All the participants showed at least one comorbidity and took more than one medicine, including medications that could alter the gustatory perception. However, the data analysis (Mann-Whitney Test) did not show any difference between the basic tastes and the usage of medications and diagnosis of participants from this study.

There was no influence in relation to gender for sensitivity to basic tastes. It should be noted that the mean solute concentration for sensitivity to sweet taste was higher for females than for males. This fact also be found in a study by Yoshikana et al [26] comparing the sweet, salty, sour and bitter taste detection thresholds among groups of young and old, where women presented recognition thresholds significantly lower than the men to the sweet, salty and bitter

tastes. In this study only for sweet taste the average was higher for the female versus the male case (3.048 and 2.667 g/L, respectively). For the other tastes, the mean values of males were higher than those of females, indicating that it could require greater quantity of solute to detect tastes.

Passos et al [27] developed a study with elderly and young adults to assess sensitivity to salty and sweet tastes, resulting in that the elderly assessed needed approximately eight times more sodium chloride than adults to detect the presence of this component and approximately four times more sucrose than adults to detect the presence of this substance. These data suggest that age may influence the detection of basic tastes, as found in the present study, in which there was statistical difference in relation to the detection of salty and sweet tastes and the age group.

This study observed the greater preservation of salty and umami tastes by the elderly. The bitter taste was more preserved than a sweet one. In relation to sweet and sour, there was no difference between the detection of the two tastes, with these being the least preserved when compared to the others ones. The data corroborate with a study conducted by Neumann et al [23], in which sensitivity to sweet, salty, sour, and bitter tastes was compared between adults and the elderly. Mingioni et al [28] showed that the elderly are able to identify differences between sweet and sour concentrations in products and that this ability is relatively stable with age. Other researchers say that the perception of umami increases, while the sour and bitter tastes decrease as the individual gets older [25], agreement with our search. Sergi et al [25] show the preservation of perception by the elderly of basic tastes, but this fact besides not totally clear. However, they point out that this sensibility could impact food preference and influence health.

Since salt sensitivity is one of the most preserved, nutritional orientation in relation to salt addition in food preparation and consumption could be better reviewed and oriented to this population, where there is a high proportion of hypertensive individuals. The decrease in salt intake could help control the blood pressure of this population. This sensitivity can often determine preferences for certain foods or preparations and should be evaluated for a better understanding of the elderly's eating behavior.

The variables of gender and nutritional status evaluated did not influence the detection of umami taste, but the elderly in general detected the solute for this taste in the majority in the smallest the solution offered, which represents being sensitive to this taste. This fact is of great interest, since only with little concentrations already this taste is felt, which helps to better understand the habits and food consumption of this group.

There was a difference in the detection of umami taste and the age range in the present study, and the knowledge of sensitivity may be beneficial for the nutritional orientation of the elderly. Since monosodium glutamate is a flavor enhancer, umami food sources could be indicated in the daily life of this population to improve the palatability and food acceptance, reducing the need to add salt and contributing to the improvement of the nutritional quality of the food, guaranteeing an adequate nutritional status.

Changes in habits according to age should be further explored and using food rich in monosodium glutamate to enhance the flavor of the preparations may improve food acceptance and quality of meals consumed, including the reduction of salt and sweet preparations.

The presence of diseases in a large part of the elderly population, in particular, cardiologic and non-transmissible chronic diseases, require attention to the quality of ingested food. Although there are several pharmacological interferences on basic tastes detection, there is always a role for age, gender and nutritional status on food selection and preference

5. Limitations

The cognitive limitation was a factor that excluded several elderly individuals who would be able to participate according to the other inclusion criteria. Smoking and drinking habits also meant that some elderly could not be included in the research.

Another limitation was the fact that the communities in which the data were collected were controlled in relation to the food consumption and the main meals of the day were provided at the places of care and this supply and consumption could influence the nutritional status of the elderly.

6. Conclusion

The findings of the present study demonstrate that salty and umami tastes were the most preserved in this elderly population and that there is no correlation of basic tastes with gender and nutritional status. Age was a variable that influenced the sensitivity to sweet and salty tastes, indicating that as the individual's age, they need a higher the concentration of salt or sugar to feel these tastes, in other words, the sensitivity to these tastes decreased and that they can influence their preferences and food acceptance. Information that if evaluated together with consumption information can establish menus, control the consumption of sweet and salty preparations and guide a more adequate and balanced diet for the elderly.

Compliance with ethical standards

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Disclosure of conflict of interest

There are no conflicts of interest relevant to this research to disclose.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.”

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