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Threshold of salty taste recognition and estimate of sodium intake among kidney-transplant recipients

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Abstract

Objectives: The study aimed to evaluate the threshold of salty taste recognition and the estimate of sodium intake among kidney-transplant recipients who attend the renal clinic in Chapecó, Santa Catarina, Brazil. *Methods:* Study with descriptive nature, quantitative approach, based on a case study. The sample consisted of 52 patients, who tasted saline solutions until recognizing the lowest concentration of salty taste. The threshold was represented by the average value of concentrations where "recognition" and "non-recognition" occurred. Other data were collected from medical records. *Results:* Most of the sample (63.5%) showed a threshold regarded as normal or below normal, i.e. less than or equal to 0.01 mol/l (0.91 g/l) and the average salt intake was 10.7 g/day, estimated from urinary sodium excretion. There was no significant association between the classification of salty taste recognition thresholds and some of the variables under study, namely: age, gender, body mass index (BMI), blood pressure, antihypertensive drug use, and estimated salt intake from urinary sodium. However, if evaluating the association between the amount of the lowest concentration recognizing salty taste and age, it shows up as statistically significant (r_s = 0.339; p = 0.014). Older patients had higher salty taste recognition thresholds. *Conclusion:* Although there is a need for further research on the subject, a high estimate of salt intake from urinary sodium is observed, and this reality should be carefully addressed, especially for elderly patients, who have a higher salty taste recognition threshold and may increase salt intake to make

food more pleasant to their taste. Not only kidney-transplant recipients, but also the Brazilian population as a whole, require public health actions to reduce salt intake.

Key words: Taste Threshold. Kidney Transplantation. Sodium Chloride.

Introduction

A healthy body has two kidneys that act in water regulation, acid-base balance, electrolytes in the body and in the excretion of the products of metabolism through urine. In addition, kidneys influence the systemic blood pressure by renal regulation.[1]

In chronic kidney diseases (CKD), there is a progressive deterioration of the renal function and a consequent retention of nitrogenous substances in the blood.[2] When a severe kidney failure occurs, patients are treated with dialysis until a kidney transplant is performed.[3] What happens is that, after a kidney transplantation, the use of the drugs that are necessary may cause side effects, such as high blood pressure.[4] Not enough, systemic high blood pressure (SHBP) is one of the main causes of CKD. In this context, SHBP may be either the cause or consequence of CKD, and the concurrent occurrence of both these disorders represents a great risk for cardiovascular diseases.[5]

By the way, the 6th Brazilian Hypertension Guidelines emphasizes that excessive salt intake is clearly the major environmental trigger of high blood pressure.[6] A high-sodium diet leads to an excessive release of the natriuretic hormone, which can indirectly increase blood pressure.[7] On the other hand, sodium, as well as sugar and fats, are responsible for providing taste to the foods consumed by the world population every day.[8]

The sensory quality is a function of the stimuli provided by foods as well as the physiological and sociological conditions of the individuals who evaluate it, in the environmental context where such individual and the product itself are.[9]

Assessment of salty taste sensitivity is used in health care and in sensorial analysis applied to the Foods Science and Technology to evaluate taste and identify ageusia or hypogeusia of diverse sources, identifying the individuals who are at risk or consume salt in excess.[10] Thus, the concentration of sodium chloride that is required for recognizing salinity varies in each individual. While an individual considers a salt solution very salty, it can be not enough to be recognized by another. [11] However, according to Guyton &Hall,[12] from a saline solution of 0.01 mol/l (0.91 g/), one can identify the taste of salt. Nilsson[13] showed that the need for more concentrated solutions than 0.91 g/l to identify salt is considered an alteration of the salt gustatory sensitivity.

Patients with CKD or with kidney transplant present taste alterations due to the diverse oral occurrences caused by the disease itself or the use of drugs. [14,15] In this context, the aim of this study was to evaluate the salt taste recognition threshold and the estimated sodium intake by kidney-transplant recipients who attend the renal clinic of Chapecó, SC, Brazil.

Methodology

This is a descriptive, quantitative study based on a case study. Descriptive researches have as main objective the description of the characteristics of a given phenomenon, and case studies seek to deepen the proposed issues.[16] The sample used in this experiment was made up of 52 kidney-transplant patients, representing 29.88% of the universe of 174 kidney-transplant patients that were assisted by the renal clinic in Chapecó in January 2014. Data were collected in the same month. Individuals with any acute illness such as fever, flue, sore throat, among others, during the period of data collection, were excluded from the survey, as well as children under age of 18 years who did not agree to participate. At first, they were asked their names; subsequently, they were sent individually to a room where the salt taste recognition threshold test was performed.

For each participant, sodium chloride solutions (NaCl) were used in increasing concentrations, varying from the lowest content of 0.002 mol/l (0.140 g/l) to the highest concentration of 0.250 mol/l (14.610 g/l). Using a dropper, four drops of the test solution were applied to the tip of the tongue of the individuals. After ten seconds without breathing or shutting the mouth, following the order of NaCI concentration, the individual should indicate when some stimulus was recognized. In this case, the same solution concentration was repeated. Such procedure continued until two successive recognitions of the salty taste occurred in the same series.[17]

Each individual's threshold is represented by the mean concentrations in which "recognition" and "non-recognition" occurred.[18] It was considered as normal recognition threshold a saline solution of 0.01 mol/l (0.91 g/l); solutions below this level were considered below normal, and higher solutions were considered recognition threshold above normal.[12]

Between the tests, the mouth was washed with distilled and deionized water. Thirty seconds was the interval between successive tests. The NaCl solutions were manufactured by the Dietetics Laboratory of the Community University of the Chapecó Region (Unochapecó) and stored in glass bottles with lid in a dry place, protected from light and under room temperature.[17] The droppers did not contact the tongue to avoid contaminations.

The Research Ethics Committee approved the study under process no. 265/2013.

Other data, such as age, gender, use of antihypertensive drugs, high blood pressure, weight, height and urinary sodium excretion were collected from the patients' medical records. The body mass index (BMI) was calculated considering the ratio between the weight (in kilograms) and the squared height (in meters). The BMI classification for individuals aged less than 60 years was the one proposed by the World Health Organization (WHO),[19] as follows: low weight: BMI <18.50 (Kg/m^2); normal weight: BMI 18.50-24.99 (Kg/m^2); overweight: BMI ≥25.00 BMI (Kg/m^2); pre-obesity: ≥25.00 – 29.99 IMC (Kg/m^2); obesity class I: BMI ≥30.00 – 34.99 (Kg/m^2); obesity class II: BMI ≥35.00 – 39.99 (Kg/m^2); obesity class III: BMI ≥40.00 BMI (Kg/m^2).

The nutritional status of the older persons (over 60 years) was assessed, according to the cutoff points proposed by the Pan American Health Organization [20] in the Health, Welfare and Aging project, which conducted surveys in Latin American countries, including Brazil, as follows: Underweight: BMI <23 kg/m^2; Normal weight: BMI 23-28 kg/m^2; Overweight: BMI >28-30 kg/m^2; and Obesity: BMI >30 kg/m^2.

Optimum blood pressure value for persons with CKD is <130 x 80 mmHg.[6] Therefore, the individuals with systolic blood pressure ≥ 130 and/or diastolic blood pressure ≥ 80 mmHg were considered with high blood pressure, and those with pressure levels and/or used antihypertensive drugs were considered hypertensive.

The variables were expressed as mean and standard deviation or median and interquartile range, depending on their distribution. The categorical variables were described as absolute and relative frequencies.

To compare the means of the ratings of salt taste recognition threshold, it was used the one-way Analysis of Variance (ANOVA). In case of asymmetry, the Kruskal-Wallis test was used. To compare the proportions, the Pearson's chi-squared test or Firsher's exact test were applied. To evaluate the association between the continuous variables, Pearson's or Spearman's linear correlation coefficients were used. The significance level used was 5% ($p \leq 0.05$) and the analyses were performed by the SPSS software, version 21.0.

Results and discussion

Out of a total of 174 kidney-transplant recipients that attend the renal clinic, 52 individuals participated in the study (29.88%). Table 1 presents their data.

Table 1. Characterization of the sample of kidney-transplant recipients attended by the Kidney Clinic. Chapecó-SC, 2014.

Variables	n=52
Age (years) – mean ± SD	45.4 ± 13.9
Gender – n (%)	
Male	35 (67.3)
Female	17 (32.7)
Weight (kg) – mean ± SD	71.9 ± 13.7
Height (cm) – mean ± SD	166.7 ± 8.24
BMI (kg/m^2) – mean ± SD	25.8 ± 3.9
BMI rating* – n (%)	
Underweight	3 (5.8)
Normal weight	23 (44.2)
Overweight	20 (38.5)
Obesity	6 (11.5)
Systolic Blood Pressure (mmHg) – mean ± SD	126.9 ± 12.0
Diastolic Blood Pressure (mmHg) – mean ± SD	81.0 ± 8.7
High blood pressure levels ** – n (%)	44 (84.6)
Use of antihypertensive drugs – n (%)	38 (73.1)
Hypertension *** – n (%)	50 (96.2)
Estimation of salt intake as determined by the level of sodium in the urine (g/day) – median (Percentiles 25-75)	10.7 (7 – 15.7)

* According to the WHO classification for individuals aged less than 60 years and PAHO classification for individuals aged 60 years and over. ** Systolic Blood Pressure ≥ 130 and/or Diastolic Blood Pressure ≥ 80. *** Considered hypertensive if the individual has high blood pressure levels and/or uses antihypertensive drugs.

The mean age of the participants was 45.4 years, with prevalence of males, and the majority is overweighed or obese (50% of the sample).

Weight gain and development of obesity occur more often during the first six months after a renal transplant, with an average increase of 12 to 15% of the initial body weight in the first year. [21] Among the main causes is the increased well-being after a successful kidney transplant, the freedom to choose foods with fewer restrictions, as well as high calorie intake, sedentary lifestyle and, especially, an increased appetite because of the use of high doses of steroids. It has also been shown that the chronic treatment with glucocorticoids leads to an increase of foods intake.[22]

Although 73.1% of the patients make use of antihypertensive drugs, nearly 85% of the patients had high blood pressure levels. It is worth noting that the renal patient, after receiving the transplant, must use immunosuppressive drugs to avoid rejection. In the long term, the use of these drugs has hypertension as an adverse effect, which may vary depending on the class of this drug.[23] Another justification in this study can be the urinary sodium excretion, which showed an average estimated salt intake above the recommended daily level of 10.7 g. This value is similar to the salt intake by the population in general, based on the Family Budget Survey (FBS) conducted by IBGE in 2008 and 2009, which indicated that each Brazilian consumed on average 11.38 g of salt/day, being cooking salt the main source of consumption. The south region of the country was in the third position regarding the highest daily salt consumption in Brazil, with 12.91 g of salt/day, while the WHO recommends a salt intake not exceeding 5 g/day.[24,25]

According to the Ministry of Health, [8,26] an indirect estimation based on the amount of salt per inhabitant sold by the Brazilian industries, sodium consumption in Brazil exceeds the maximum recommended limit. The WHO recommends reduction of sodium intake to diminish high blood pressure and the risk of cardiovascular disease, stroke and heart diseases. [27]

Molina and collaborators [28] cite in their study that high sodium ingestion may also be related to a higher intake of foods cooked with ready-to-use spices, which are very accessible and practical, in addition to a higher consumption of processed foods.

When the relation between the prevalence of hypertension and the level of industrialization among the populations was examined, the Intersalt study[29] indicated an association of sodium intake with hypertension. The western populations and with high salt intake had higher percentages of SHBP, while rural or more primitive populations that did not use salt showed lower prevalence or no case of SHBP.

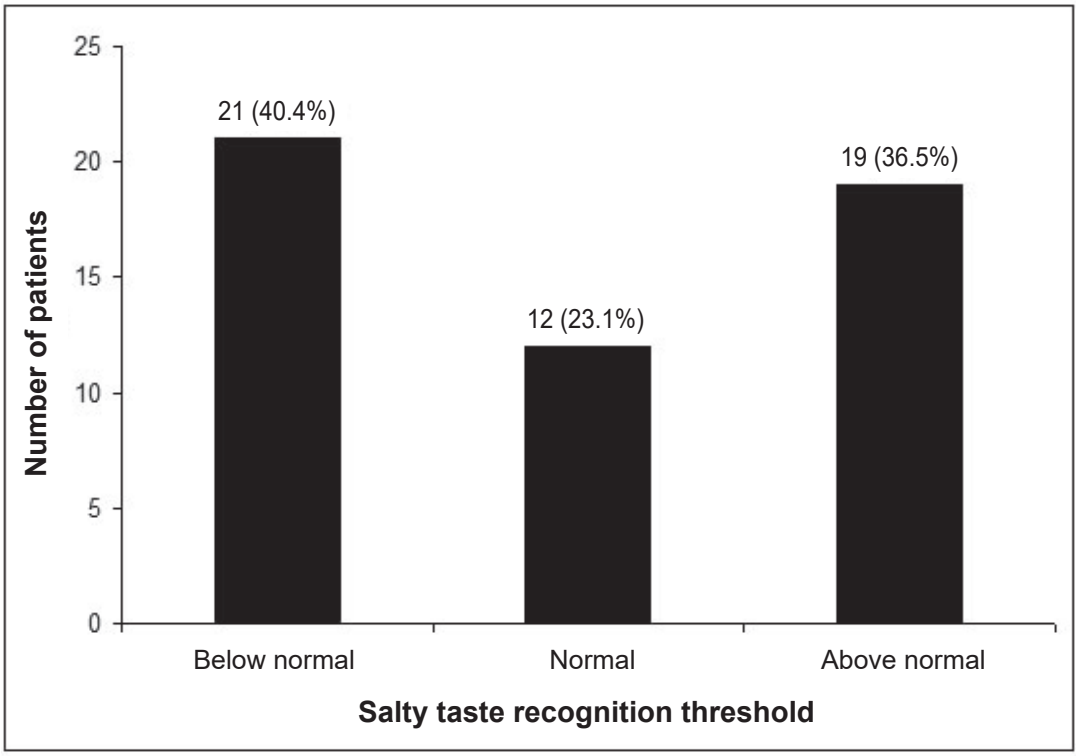

Figure 1. Distribution of the patients according to the salty taste recognition threshold. Chapecó-SC, 2014.

Sensory analysis is the interpretation of the critical analysis of a food using the five senses, and therefore is considered an examination of the sensory properties of a product.[30]

The recognition threshold corresponds to the concentration of a given solute, necessary to provide its identification. The threshold value is often higher than the detection threshold.[31] While detection is the lowest concentration at which a stimulus is perceived as being different from water, recognition is a statistical concept. Conventionally, the threshold value usually refers to the concentration at which the average individual detects or 50% of them recognize. [32] Regarding the population under study, the salt taste recognition threshold can be seen in Figure 1.

Table 2. Association of the variables under study with the salty taste recognition threshold. Chapecó-SC, 2014.

Variables	Threshold value below normal (n=21)	Normal threshold value (n=12)	Threshold value above normal (n=19)	p
Age (years) – mean ± SD	40.3 ± 13.1	45.3 ± 10.7	50.9 ± 15.0	0.054*
Gender – n (%)				0.162**
Male	17 (81.0)	8 (66.7)	10 (52.6)	
Female	4 (19.0)	4 (33.3)	9 (47.5)	
BMI (kg/m^2) – mean ± SD	25.7 ± 3.0	27.0 ± 4.0	25.1 ± 4.6	0.427*
BMI rating – n (%)				0.159**
Underweight	0 (0.0)	0 (0.0)	3 (15.8)	
Normal	9 (42.9)	5 (41.7)	9 (47.4)	
Overweight	11 (52.4)	5 (41.7)	4 (21.1)	
Obesity	1 (4.8)	2 (16.7)	3 (15.8)	
Systolic Pressure (mmHg) – mean ± SD	128.1 ± 12.5	129.2 ± 12.4	124.2 ± 11.2	0.458*
Diastolic Pressure (mmHg) – mean ± SD	80.0 ± 8.4	84.2 ± 9.0	80.0 ± 8.8	0.353*
High pressure levels – n (%)	18 (85.7)	10 (83.3)	16 (84.2)	0.982**
Use of antihypertensive drugs – n (%)	12 (57.1)	11 (91.7)	15 (78.9)	0.076**
Hypertension – n (%)	20 (95.2)	12 (100)	18 (94.7)	0.730**
Estimation of salt intake through urinary sodium (g/day) – mean ± SD	11.3 (6 – 17)	11.6 (9 – 15)	9.9 (7 – 12)	0.626***

* One-way Analysis of Variance (ANOVA); ** Pearson's chi-square test; *** Kruskal-Wallis's test.

There was no significant association between the salt taste recognition thresholds with any of the variables studied (Table 2). However, when the lowest concentration at which the salt taste was recognized is associated with age, the association is statistically significant (r_s=0.339; p=0.014), as shown in Figure 2. The older patients presented higher salt taste recognition thresholds.

What happens is that over 60 years, there is a decrease of the taste buds, responsible for the sense of taste, causing changes in the taste threshold, i.e., a higher concentration of sweet, salty, acid or bitter substances are necessary for older persons to distinguish the taste of water and the flavors. The difficulty that older persons have in detecting the salty taste leads them to put more salt on foods.[9,33]

The senses of smell and taste, linked to the foods tasting, decreases greatly as a person ages and become less efficient, leading older people to ingest more harmful food, like salt and sugars, causing damages to health.[34]

A study conducted at the University of Brasilia, in 2008, found that people over 60 years required approximately 25 times more salt than adults to detect the presence of this substance. The adults detected the salty taste from solutions containing 0.010% of salt (NaCl), but the older individuals only detected the salty taste from solutions with 0.266% of salt (NaCl).[35]

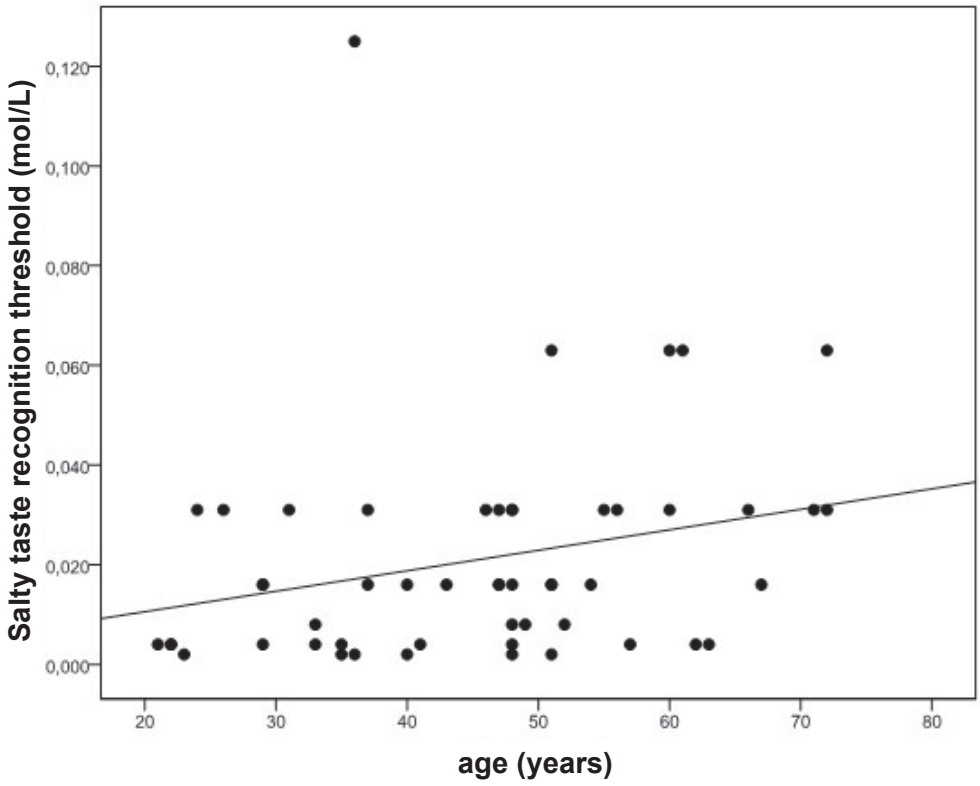

Figure 2. Association of age and the salyt taste recognition threshold. Chapecó-SC, 2014.

Although not significant (p=0.135), patients using antihypertensive drugs indicated a higher estimated daily salt ingestion in grams through urinary sodium than those who did not take medication [10.9 (8-16) g/day vs 8.4 (4-14) g/day, respectively].

Not all individuals have salt sensitivity and, therefore, not all of them develop hypertension when exposed to high levels of salt intake. For reasons that are still unclear, it has been suggested renal failure in excreting the saline overload with a consequent increase of the volume of circulating blood and/or sympathetic activation, with consequent constriction of the blood vessels.[36]

Perin and collaborators[37] showed that the average salt intake by a hypertensive population was of 12.1 g/day. Polónia and collaborators[36] found a very similar result, of 12.4 g/day. In the present study, the estimated salt consumption through urinary sodium excretion was of 10.7 g/day, for hypertensive and normotensive individuals.

When sodium intake exceeds the body needs, there are mechanisms that excrete the surplus to maintain normality. However, there is a limit for sodium excretion, and a higher ingestion causes an increase of sodium concentrations and consequent water retention, increasing the volume of circulating blood and blood pressure.[38]

Studies have shown a direct relationship between urinary sodium excretion and mean blood pressure. When blood pressure rises, there is an immediate increase of urine output and renal sodium loss, a phenomenon called pressure natriuresis.[39-41] However, regarding the fact that the pressure levels are higher or lower than the level considered normal, the estimated salt intake was similar between the groups [10.8 (7-15) g/day vs 10.3 (6-12) g/day, respectively; p=0.645]. This can be explained by the fact that some individuals excrete larger amounts of sodium without raising the blood pressure, while others don't.[42]

The blood pressure response to sodium intake is different in each individual. Some people present higher tendencies of fluctuations, in either dietary salt restriction or addition conditions, a factor known as salt sensitivity.[43]

Finally, the use of antihypertensive drugs did not show a significant relation with the fact that the pressure levels were over or below normal (72.7% vs 75%; p=1.000). Referring again to the study by Perin and collaborators[37], we can state that even in patients that take three classes of antihypertensive drugs, the blood pressure levels indicate an unsatisfactory control of the blood pressure.

Conclusions

There was no significant association of the salty taste recognition thresholds with any of the variables studied, which were age, gender, BMI, blood pressure, use of antihypertensive drugs and estimation of salt intake through urinary sodium excretion. The majority of the individuals (63.5%) had a threshold value considered normal or below normal, i.e., less than or equal to 0.01 mol/L (0.91 g/L).

The use of antihypertensive drugs showed no correlation with the fact that the blood pressure was over or below the recommended levels. Although 73% of the sampled population used such drugs, 85% had high blood pressure.

The daily average salt intake, as estimated by the sodium excreted through urine, was 10.7 g. Based on previous studies, we can see a relationship between salt intake and SHBP. Although not significant, the higher estimate of salt intake was found in hypertensive patients under medication.

Statistical significance was only found in the relation of lower salty taste recognition thresholds with age. Older people are the ones most affected, requiring larger amounts to recognize the flavor.

Although further studies on this subject are necessary, it was noted a high salt consumption, a reality that must be carefully addressed. Not only the kidney- transplant recipients, but also the Brazilian population in general, need public health care actions aiming to reduce salt intake.

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