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Association of Salt Taste Sensitivity Threshold with Blood Pressure and Obesity Indicators among Healthy Young Adults

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ABSTRACT

Background: Salt preference in diet can vary according to the salt taste sensitivity threshold among the individuals. This study aims to know the salt taste sensitivity threshold (STST) among healthy Nepalese adults and its association with blood pressure and anthropometric measures like Body Mass Index, waist Circumference and waist by hip ratio.

Methods: This cross-sectional study was carried out among 104 healthy Nepalese volunteers between 20-30 years of age in the department of Clinical Physiology, Maharajgunj Medical Campus. The ethical clearance from Institutional Review Committee was taken in From June to October, 2024. The salt taste sensitivity threshold was elicited with different concentrations of salt solutions. The blood pressure, and anthropometric measures like body mass index, waist circumference and waist by hip ratio were measured. All inferential statistics were calculated at a 5% level of significance.

Results: Among the study participants, 86.5% were in normal STST category. The mean body mass index (21.60 ± 2.82 kg/m^2), waist circumference (78.03±11.10 cm) and waist by hip ratio 0.74±0.052) in high STST participants was comparatively more with statistically significant difference (P: 0.04; P <0.001, P<0.001). The association of systolic blood pressure was significant with STST (P:0.004). Also, the association of waist circumference and waist by hip ratio with STST was significant among female (P: 0.005; P:0.006).

Conclusions: The healthy participants had mostly normal STST. The elevated systolic blood was associated with high STST which suggests of reducing salt intake for minimizing such risks.

Keywords: Blood pressure; Salt; Taste threshold; Waist circumference; Waist by Hip ratio.

INTRODUCTION

The salt taste sensitivity threshold (STST) is an individual's ability to recognize the taste of sodium. A high STST suggests the individual is more likely to have excessive salt intake which was associated with elevated blood pressure even among healthy adults .[1]

An Indian study has observed higher salt taste sensitivity and higher blood pressure with family history of hypertension.[2] The high salt intake has been associated with elevated blood pressure even in healthy adolescents which was found to be stronger by the presence or severity of obesity.[3]The overweight and obese individuals are also prone to consume more dietary salt and their Body Mass Index also correlates with increased salt intake.[4,5] The significant association between STST and blood pressure has been observed among different other population.[6-8] This study has thus an objective to know the STST among healthy young Nepalese adults and associate it with blood pressure and obesity indicators.

METHODS

This cross-sectional study was carried out in the department of Clinical Physiology, Maharajgunj Medical Campus from June to October, 2024. The study was conducted after getting the ethical clearance from the Institutional Review Committee-IOM with the help of departmental grant from Maharajgunj Medical Campus and informed written consent was also taken from

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each participant. Sample size was calculated with the formula, n= $2(Z\alpha+Z\beta)^2$ S^2/ d^2 where S: larger Standard deviation and d: Mean1- Mean2 and at 95% confidence interval; n = 2. $(1.96+1.28)^2$. 5^2/ $(26.6-23.4)^2$ =52 as per previous study.[1] The healthy young Nepalese adults who were undergraduate medical students of 18-30 years age from both genders were included by convenient sampling method with voluntary participation. The participants with previous medical diagnosis of hypertension, diabetes mellitus or chronic kidney disease and pregnant women were excluded.[9] For the dependent variables, the weight of the participant was measured in a well calibrated weighing scale placed on a flat surface. The height was measured with the help of anthropometric rod and ruler at vertex in an erect posture and with knees and heels together and arms extended alongside the body. The Body Mass Index was calculated as an obesity indicator. It was further classified into BMI I i.e. underweight if below 18.5kg/m^2; BMI II i.e normal weight if between 18.5-24.9 kg/m^2;BMI III i.e. pre-obesity if between 25.0-29.95kg/m^2 and BMI IV i.e. obesity class I if between 30.0-34.95kg/m^2 .[10] Also, the waist circumference was measured with the help of inelastic measuring tape placed horizontally at the midpoint between the lower edge of the last rib and the superior iliac crest of each participant. The hip circumference was measured from the highest diameter area from the buttock region. The waist by hip ratio was also calculated as another indicator of obesity considered in this study. The waist circumference of <90cm and waist hip ratio of ≤0.90 was considered of normal for male otherwise it was considered in risk category. The waist circumference of <80 cm and waist hip ratio of ≤0.85 was considered of normal for female otherwise it was considered in risk category.[11] The blood pressure was recorded after 5 minutes with auscultatory method with a well calibrated aneroid sphygmomanometer. The systolic and diastolic component of blood pressure were recorded. The blood pressure of <120mmHg systolic and <80 mmHg diastolic was considered as normal blood pressure.[12]

For independent Variable, nine solutions of sodium chloride were made as: 1)4 mmol/l = 0.228 g/l; 2) 8 mmol/l = 0.456 g/l; 3) 15 mmol/l = 0.913 g/l; 4) 30 mmol/l = 1.826 g/l; 5) 60 mmol/l = 3.652 g/l; 6) 120 mmol/l = 7.305 g/l; 7) 250 mmol/l = 14.610 g/l; 8) 500 mmol/l = 29.220 g/l; and 9) 1,000 mmol/l = 58.440 g/l.[1]The solutions were prepared using distilled water and analytical balance for solute measurements and were placed in a dry environment at room temperature. The subjects were warned not to smoke, eat over a period of at least two hours preceding the test. Four drops of the test solution were applied to the tip of the individual's tongue. After 10 seconds without breathing or closing his or her mouth, the subject asked what the taste felt like.[1] Separate glass droppers were used for different concentrations of NaCl solutions. The solutions were offered in increasing concentrations until the individual correctly identified the taste that will be felt. After making the correct identification, solutions of decreasing concentrations were tested, until an error of identification occurs. The concentration immediately higher than this was considered to be the NaCl recognition threshold (STST).[1] Individuals with normal STST were those who identified the salty taste in solutions 1 to 4 (≤ 1.826 g/l of NaCl [30 mmol/l]), while individuals with high STST were those who identified salty taste in solutions 5 to 9 (≥ 3.652 g/l of NaCl [60 mmol/l]). To avoid possible adaptations of the taste sensors, the subjects were asked to wash out their mouth with distilled water.[13,14]

Figure 1. Glass bottles with different NaCl solutions.

Figure 2. Glass bottles and glass droppers for Salt Taste Sensitivity Threshold.

IBM SPSS version 16 was used for data analysis. The independent T test was used to compare the mean of different dependent variables with 2 categories of independent variable. The association of the dependent variable with the categories of salt taste sensitivity threshold was done with the help of chi square tests in which Pearson Chi square was used if cell count was more than 5 in each cell category and Fisher's Exact Test if the cell count was <5. The P value < 0.05 was considered statistically significant and <0.001 was considered statistically highly significant.

RESULTS

Among 104 participants, 90 (86.53%) of them had normal salt taste sensitivity threshold as shown in figure 1. The male distribution in high salt taste sensitivity threshold category was comparatively more than female.

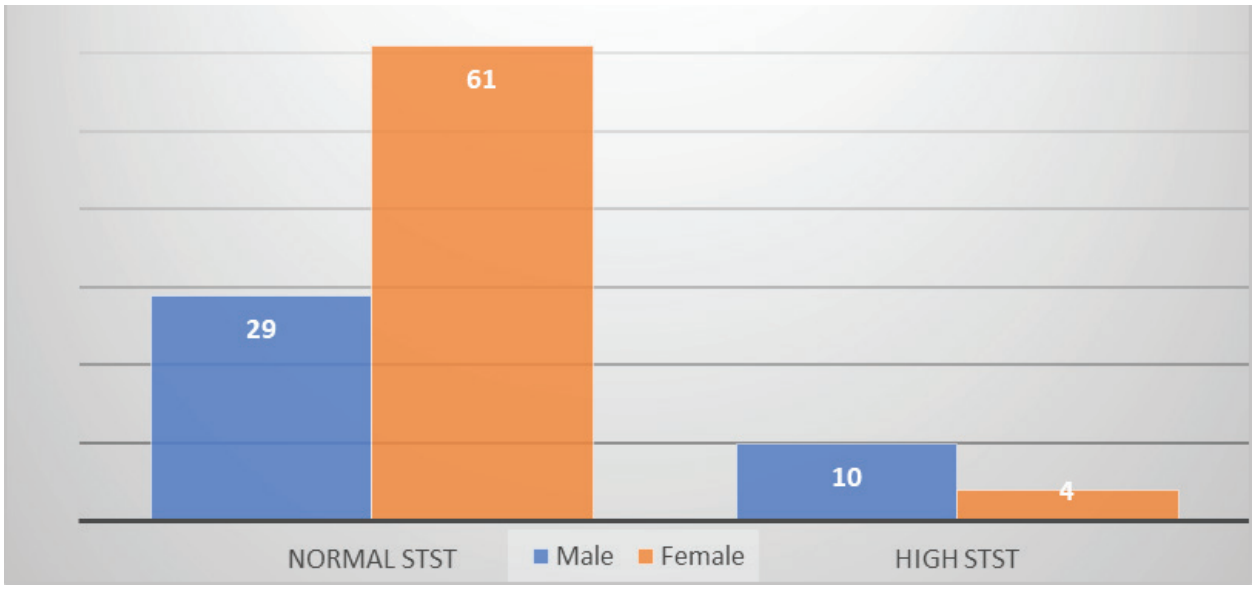

Figure 3. Distribution of participants in different categories of salt taste sensitivity threshold.

The majority of male participants detected salt solution at 15mmol/l and 30mmol/l as shown in fig 2. The majority of female participants had detected salt at 8mmol/L and 15mmol/L as shown in figure 3.

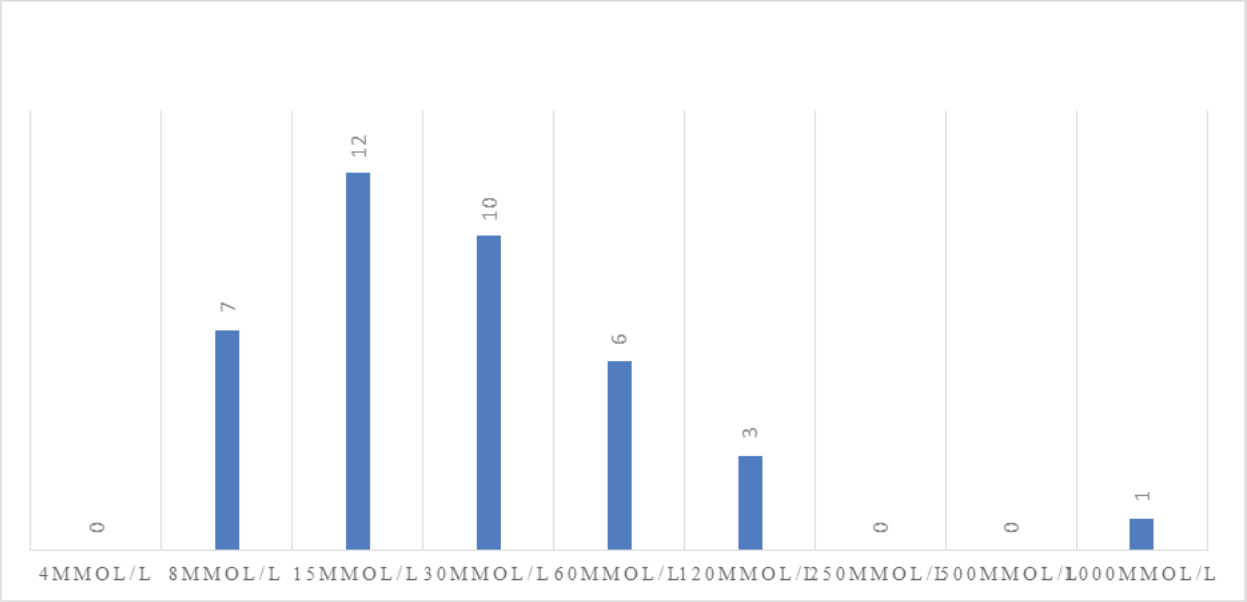

Figure 4. Visual representation of the facial changes seen in a neonate experiencing pain.[7]

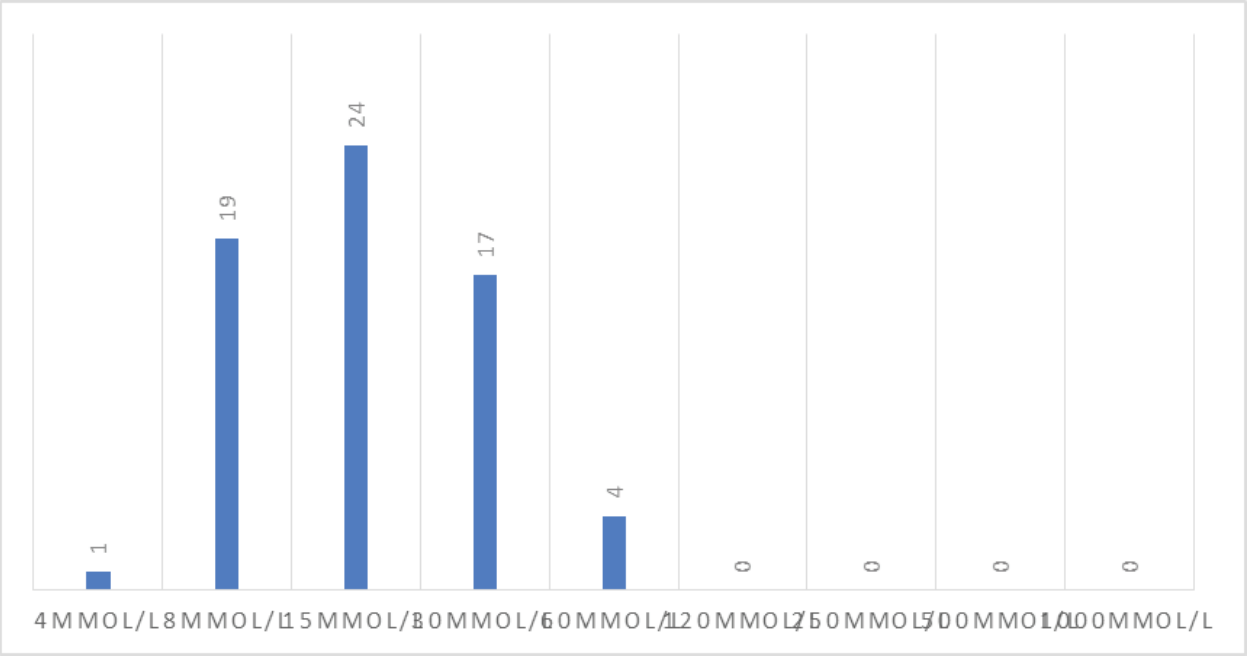

Figure 3. Distribution of Salt taste sensitivity threshold among female participants.

The mean distribution of systolic blood pressure, body mass index, waist circumference and waist hip ratio were more in participants with high salt taste sensitivity threshold as shown in table 1. The mean comparison done between the anthropometric measures like body mass index, waist circumference and waist by hip ratio in between the normal and high salt taste sensitivity threshold groups was statistically significant with P value 0.04, <0.001 and <0.001 respectively among total participants.

Table 1. Mean Comparison of different dependent variables between different STST categories

Variables	Normal STST Mean ± S.D.	High STST Mean ± S.D.	P value
Systolic Blood Pressure (mmHg)	105.93 ± 13.07	113.00 ± 14.24	0.06
Diastolic Blood Pressure (mmHg)	69.13±8.56	69.00±10.86	0.95
Body Mass Index (Kg/m^2)	21.60 ±2.82	23.33 ±3.37	0.04
Waist Circumference (cm)	68.90 ± 7.22	78.03 ± 11.10	<0.001
Waist/Hip Ratio	0.74 ± 0.05	0.80 ± 0.06	<0.001

The systolic blood pressure had statistically significant association with salt taste sensitivity threshold with P value of 0.004. The other anthropometric measures considered as obesity indicators had no any association with STST as shown in tab 2.

Table 2. Association of blood pressure and different anthropometric measures with different STST categories

Variables		Normal STST	High STST	Chi Square Tests (P value)
Systolic Blood Pressure (total)	<120 mmHg	79	8	0.004*
	>120mmHg	11	6	
Diastolic Blood Pressure (total)	<80 mmHg	72	10	0.488**
	>80 mmHg	18	4	
Waist Circumference (male)	<90 cm	29	0	0.256**
	≥90 cm	1	1	
Waist Circumference (female)	<80 cm	57	4	1**
	≥80 cm	4	0	
Waist Hip Ratio (male)	≤0.90	29	0	0.256**
	>0.90	9	1	
Waist Hip Ratio (female)	≤0.85	60	1	1**
	>0.85	4	0	
Body Mass Index categories (total)	<18.5	11	1	0.315**
	18.5-24.9	68	9	
	25-29.9	10	4	
	>30	1	0	

*Pearson Chi Square; ** Fisher's Exact Test; Level of significance: 95%

DISCUSSION

This study has found that 86.5% of the participants had salt taste sensitivity threshold in normal category. Among the high salt taste sensitivity category, male distribution (9.61%) was comparatively more than female (3.84%). The result was similar to the study conducted among healthy adults in southern Brazil where 77.9% had normal STST followed by high STST but the percentage distribution of female with higher STST was more in comparison to male.1 Similarly, most of the control healthy group in an Indian study had normal salt taste threshold in comparison to elevated Salt taste threshold. 15This study has also found that the mean of STST (g/L) among the participants was 2.03±5.75, in male it was 3.45 ±9.22 and in female, it was 1.17±0.83. Similarly, the salt detection threshold for Malay, Chinese and Indian students were 1.56, 1.19 and 0.90 mM respectively.16There's lack of further researches regarding the mean distribution of salt taste sensitivity threshold in adults of different population.

This study has also found that the mean of waist circumference, waist by hip ratio and body mass index in participants with high salt taste sensitivity threshold was comparatively more. The mean comparison had also showed that

the mean difference was statistically significant for the anthropometric measures like waist circumference, waist by hip ratio and body mass index in between different categories of salt taste sensitivity threshold. Similar result was also seen in a Caucasian study with the statistically significant increased mean difference in waist Circumference (84.6 ± 13.3 cm), increased BMI (26.6 ± 5.0 kg/m2) among the healthy participants with higher STST (P: 0.002; P: 0.008) .1 Higher salt intake has been significantly related to higher body fat mass in both children (P=0.001) and adults (P=0.001) after adjusting for age, sex, ethnic group, and energy intake. The results were suggestive that salt intake is a potential risk factor for obesity independent of energy intake.17Literatures have also reported that the salt intake is higher among the overweight children and the adult than among participants with normal body mass.18 This study has found the chi square association of waist circumference, waist by hip ratio, Body Mass Index with salt taste sensitivity threshold which was statistically insignificant in the study participants.

A positive correlation between blood pressure components and Salt taste sensitivity was observed in an Indian study as well. 15 This study has also found the association of systolic blood pressure with the salt taste sensitivity threshold with P value of 0.004. However, the mean comparison of systolic and diastolic blood pressure with different categories of salt taste sensitivity threshold showed no statistically significant difference in this study. The finding is contrary to the similar study conducted in healthy group in Caucasian population which had showed the statistically significant increase in systolic and diastolic component of blood pressure among participants with high STST.1 Studies have found that the high salt taste threshold is linked to hypertension in population with family history of hypertension. Still there are other literatures which shows no difference in salt taste threshold in between people with without hypertension. However, the increase in salt taste threshold is often linked to increased salt consumption in diet. This increased salt consumption promotes the development of hypertension through different pathways including increased sympathetic activity, endothelial dysfunction, vascular abnormalities and water/sodium retention. 19,20

The study has derived a preliminary result about the salt taste sensitivity threshold distribution among healthy Nepalese adults. The study should be carried out in larger scale to generalize it to our population. Also, the family history of hypertension and ethnicities could be associated with higher salt taste sensitivity threshold according to the literature. The future research in similar line should incorporate such possible factors affecting the salt taste sensitivity threshold among the participants in healthy as well as diseased group.

CONCLUSIONS

This study concludes that the maximum distribution of salt taste sensitivity threshold was normal among the participants. The systolic blood pressure had an association with salt taste sensitivity threshold even among normal healthy adults. The result can be implicated while giving counselling to the people for advocating the reduction of additional salt in diet.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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