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Research Article

Assessment of Salt Intake Markers Among Hypertensives Patients Attending Primary Care Clinic of a Nigerian Tertiary Hospital

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Abstract

Introduction: The development of hypertension has been linked to dietary sodium, hence, a low-sodium diet in conjunction with hypertensive medications has been widely recommended in getting optimum blood pressure control. Therefore, this study assesses salt intake among hypertensive patient using dietary salt markers.

Method: This quasi-experimental study investigated the salt taste threshold, overnight urine collection for sodium estimation and its relationship with dietary salt intake among 564 adult hypertensive (282 each in study and control group) attending Family Medicine Clinic of Federal Teaching Hospital, Ido-Ekiti (FETHI), Ekiti State. Respondents in the study group were taught and shown in practical terms the recommended daily salt consumption. Salt solutions were used to measure the salt taste thresholds (STT) which is the ability of respondents to discern the taste of salt in graded solutions of sodium chloride using single-blinded forced stimulus drop technique. Urinary sodium was estimated from overnight urine collection which was a low-burden alternative to the 24 hour urinary sodium excretion (USE).

Result: The baseline mean urinary sodium excretion USE (mmol/l) and mean salt taste threshold STT (mmol/l) was high in both the study and control group (210.4 ± 57.2 vs 214.0 ± 62.2; 47.3 ± 19.7 vs 49.7 ± 20.0). Post intervention, there was a statistically significant reduction ($p < 0.05$) in the mean USE and mean STT among the study group (199.4 ± 48.4 and 42.9 ± 17.7). A direct relationship between STT and USE was found and the fact that either of the two variables could serve as a marker to estimate individuals and population salt intake.

Conclusion: The dietary salt intake among hypertensive adults was high as evident by salt taste threshold and urinary sodium excretion. Educating patient through practical demonstration on quantity of recommended salt intake will help to combat the increasing burden of uncontrolled hypertension.

Keywords: Salt Intake Markers; Hypertension; Primary Care Clinic; Salt Taste Threshold; Urinary Sodium Excretion

Introduction

Hypertension is a common ailment worldwide with high prevalence. A relationship between hypertension and cardiovascular risk is well established, contributing to most cardiovascular-related mortality [1].

Epidemiological studies have shown an important role the intake of more than the recommended salt intake plays high blood pressure among the populace, resulting in high risk of stroke and other related cardiovascular diseases [2-4]. The World Health Organization (WHO) advised on consuming sodium no more than 2 gram/day or 5 gram/day for salt intake among hypertensive patients [5,6], and also the recent guidelines on hypertension as an important element of lifestyle modification recommend reducing the sodium intake [6]. An independent risk factor for cardiovascular disease like hypertension has been linked to high sodium intake [7,8].

Therefore, this necessitated why dietary sodium intake reduction was largely embraced and recommended as an important measure that should be taking seriously in preventing hypertension and obtain an optimum blood pressure control [7,9]. Despite these recommendations, the level of salt intake remains on the increase worldwide [9,10].

Various methods has been canvassed to assess the intake of salt, among which are measuring urinary excretion or estimating from dietary intake [11-13]. Salt taste threshold which is a measure of salt-sensitivity is another marker of sodium intake [14,15]. When an individual has a low threshold for a salt taste, the possibility of intake of fewer salt than one who had a high threshold is expected. Increased sensitivity would drive one to take lesser salt until reach the salt concentration identified as pleasant. High salt intake has an effect on taste perception as it gradually decreases salt taste perception, thereby raising the quantity of salt to stimulate the detection and recognition threshold of the salty taste [16-18].

Urinary sodium excretion provides an estimate of total sodium intake from all sources [19]. Twenty-four hour urine collection is popularly accepted as the gold standard method for sodium intake measurement. Twenty-four hour urinary collection-the most accurate method- is burdensome; hence overnight urine, early fasting morning urine or spot urine sampling has recently be regarded to be valid estimates and an alternative because of its affordability and convenience [12,20].

Few data exists about the relationship on amount of salt intake, salt-taste sensitivity and urinary sodium excretion. There are even inconsistencies in the results of the limited data available [14,21,22]. Hence, this study tried to establish the relationship in the use of salt-taste sensitivity threshold and the urinary sodium excretion in determining the amount of salt intake. This information we hope will be helpful in clinical practice to guide health professional on patient education as a means to reduce salt intake in hypertensive population.

Methodology

Participants

A total of 564 respondents (282 study and 282 control subjects) were recruited in hypertension clinic of general outpatient department at Federal Teaching Hospital, Ido-Ekiti by a simple random sampling technique after calculating the sample size using the appropriate sample size determination formula. Those between 18–70 years, on treatment for at least three months from the time of diagnosis and stabilized on antihypertensive drug were included in the study. All participants with taste and smell impairment, co-morbidity and are critically ill at the time of this study were excluded. Approval for the study was sought from the research and ethic committee of the institution and enrolment was by using a simple random sampling method, having gained an written informed consent from the participant.

Procedure

The study was conducted in 2 stages. Researchers had first contact with the respondents where the purpose and benefits of the study were explained to them and informed written consent was obtained in stage 1. The pre-tested questionnaire was administered. Baseline clinical data (height, weight, blood pressure) were copied from the patient's hospital folder, and salt taste threshold was assessed. Thereafter, patients were given instruction to obtain an overnight urine and to submit it the following day after the interview. In addition all the respondents in the study group were educated and shown by demonstration the recommended measure of salt for daily consumption. This phase lasted for 12 weeks (to allow for the effect of change in taste to have been established among the study group). In phase 2 of the study, all respondents' clinical data and salt intake markers were re-evaluated.

A resident doctor assisted in the administration of salt solutions coded A – E to determine the taste threshold. The investigators alongside the dietician showed respondents in the study group the recommended measure of salt (half teaspoon) for daily consumption. The investigators decoded the determined salt taste threshold of the respondents. The medical laboratory scientist assisted in the collection of urine and blood samples for sodium analysis using the Potentiometer – the Ion-selective electrodes method. Various medical complaints of all respondents were attended to during the encounter.

Measures

Assessment of salt taste thresholds

Salt solutions were used to measure the salt taste thresholds (STT) which is the extent to which respondents can recognise the taste of salt in graded solutions of sodium chloride using single-blinded Forced Stimulus drop technique [14,23]. The salt taste threshold was in grades of 5, 15, 30, 60, and 90 mmol/l of salt solution prepared by measuring sterilised salt, dissolved in distilled, de-ionised water (i.e. for 5 mmol/l solution, 0.3g of salt was dissolved in 1 litre of water, while 0.9g, 1.8g, 3.5g and 5.3g were for 15 mmol/l, 30 mmol/l, 60 mmol/l and 90 mmol/l respectively) [14]. The containers of the solutions were coded using alphabets A – E to represent each salt solution, from 5 mmol/l as A incrementally to 90 mmol/l as E). Each solution was with a different dropper to avoid admixture of the different preparations (solutions). On the tongue of the respondents were administered three (3) drops of each salt solution at room temperature starting with the lowest concentration of graded solution A (5 mmol/l), till we get to concentration E (90 mmol/l). Respondents were instructed to describe the taste perceived. The solution concentration discerned salty by individual respondent was recorded as their STT [14]. Research assistants recorded only the codes of solutions (i.e. A – E) discerned salty by the respondents and decoding was done by the investigator at the end of each day. Respondents rinsed their mouth with distilled water before application of the higher graded solution. The STT was categorised as normal STT (5-30 mmol/l) and high STT (60-90 mmol/l).

Overnight urinary sodium excretion

Participants were told to carefully collect all the overnight urinary volume, (a low-burden alternative to the 24-hour urinary sodium excretion) and to drink water normally. Urinary sodium intake estimation was based on the premise that most (90–95%) of sodium ingested was excreted in the urine [11,20,24]. Respondents were informed on how to properly collect the urine for the assessment of urinary sodium. A three-litre plastic container pre-treated with 25 ml boric acid was given to each respondent with a suitable bag to convey it and added for female is a plastic funnel. The period of collection is from 08:00pm to 08:00am. Bladder was emptied at 08:00pm which was discarded following which subsequent urine was collected in the container until the following day. The final urine collected into the plastic container at 08:00am of the following day; this was brought to the laboratory for submission and analysis. They were implored to bear with the inconveniences associated with this procedure and were also encouraged to ensure complete collection of the urine sample. Venous blood was collected for plasma sodium measurement by the laboratory research assistant and values ≤ 144 mmol/l were taken as normal while > 144 mmol/l were taken as high plasma sodium. Urine and plasma concentrations of sodium were measured with a Potentiometer – the Ion-selective electrodes method. The measured urine sodium was expressed as 24-hour sodium excretion by: multiplying the urine sodium concentration by the total volume of urine collected and multiplying the product by 24/collection time (hours) [20,25]. The urine sodium normal reference range was 40-220 mmol/l/day, while value > 220 mmol/l/day were regarded as high USE.

Statistical analysis

All data collected was analysed, after being sorted out and coded serially, using the Statistical Package for Social Sciences for Windows software version 17.0 (SPSS Inc., Chicago, IL, USA). The data was summarized with the use of means, standard deviations, proportions and percentages as appropriate. The student t-test makes comparism between the means while chi square to know the differences observed in 2 by 2 tables. Analysis was done in two stages; pre-intervention and post-intervention. A significant P-value of equal or less than 0.05 was considered.

Results

All participants had the mean age of 60.0 ± 9.3, while the predominant age group was 61-70 years for both study and control group (56.4% vs 46.5%). Table 1 showed high STT and USE {180 (63.8%) vs 178 (63.1%)} and {156 (55.3%) vs 154 (54.6%)} in both study and control groups respectively pre-intervention with no significant statistical difference ($p > 0.05$). Post-intervention,

	Pre-intervention				
Variables	**Study (n = 282)**	**Control (n = 282)**	**Total (N = 564)**	**X^2**	**p-value**
Salt-Taste Threshold (STT) (mmol/l)					
High (≥60)	180 (63.8)	178 (63.1)	358 (63.5)	0.031	0.860
Normal (<60)	102 (36.2)	104 (36.9)	206 (36.5)		
Urinary Sodium Excretion (USE) (mmol/l)					
High (>220)	156 (55.3)	154 (54.6)	310 (55.0)		
Normal (≤220)	126 (44.7)	128 (45.4)	254 (45.0)	0.029	0.865
	Post-intervention				
Salt-Taste Threshold (STT) (mmol/l)					
High (≥60)	129 (46.1)	163 (58.6)	292 (52.3)		
Normal (<60)	151 (53.9)	115 (41.4)	266 (47.7)	8.824	0.003
Urinary Sodium Excretion (USE) (mmol/l)					
High (>220)	106 (37.9)	139 (50.0)	245 (43.9)		
Normal (≤220)	174 (62.1)	139 (50.0)	313 (56.1)	8.352	0.004

Table 1: Assessment of Salt Intake Markers among respondents.

there was a significant statistical difference (p < 0.05) in STT and USE between the study and control groups.

Table 2 showed similarity in the salt intake markers for both groups pre-intervention, while post-intervention the differences in the mean STT and USE mean (42.9 ± 17.7 vs 48.6 ± 20.1 and 199.4 ± 48.4 vs 211.0 ± 62.5 respectively) were statistically significant.

	Study	**Control**		
Variables	**Mean ± SD**	**Mean ± SD**	**T**	**p-value**
Pre-intervention				
Salt taste threshold (mmol/l)	47.3 ± 19.7	49.7 ± 20.0	-1.444	0.149
Urinary Sodium excretion (mmol/l)	210.4 ± 57.2	214.0 ± 62.2	-0.704	0.481
Post-intervention				
Salt taste threshold (mmol/l)	42.9 ± 17.7	48.6 ± 20.1	-3. 589	<0.001
Urinary Sodium excretion (mmol/l)	199.4 ± 48.4	211.0 ± 62.5	-2.446	0.015

Table 2: Salt intake markers pre-and post-intervention.

t –independent t test.

Among the study group post-intervention, the mean STT reduced from 47.3 ± 19.7 to 42.9 ± 17.7 and USE reduced from

	Study		**Control**	
Variables	**Pre-intervention (n = 282)**	**Post-intervention (n = 280)**	**Phase 1 (n = 282)**	**Phase 2 (n = 278)**
Mean STT (mmol/l) ± SD	47.3 ± 19.7	42.9 ± 17.7	49.7 ± 20.0	48.6 ± 20.1
Mean difference test	t = 2.785 p = 0.006		t = 0.649 p = 0.517	
Mean USE (mmol/l) ± SD	210.4 ± 57.2	199.4 ± 48.4	214.0 ± 62.2	211.0 ± 62.5
Mean difference test	t = 2.460 p = 0.014		t = 0.569 p = 0.569	

Table 3: Effect of intervention on salt intake markers among respondents.

t- independent t test.

210.4 ± 57.2 to 199.4 ± 48.4. These reductions were statistically significant (p = 0.006 and 0.014 respectively) in table 3.

Table 4 showed that among the study group 156 (100.0%) and 99 (93.4%) of respondents with high USE also had high STT, likewise 102 (81.0%) and 144 (82.8%) of respondents with normal USE also had normal STT pre and post-intervention respectively. This showed that there was a significant (p = 0.000) direct relationship between USE and STT with strong (0.83) and moderate (0.73) levels of agreement pre and post-intervention respectively. Likewise among the control group 154 (100.0%) and 130 (93.5%) of respondents with high USE also had high STT, likewise 104 (81.2%) and 106 (76.3%) of respondents with normal USE also had normal STT in phases 1 and 2 of the study respectively. This showed that there was a significant (p = 0.000) direct relationship between USE and STT with strong (0.83) and moderate (0.70) levels of agreement pre and post-intervention respectively.

	Urinary Sodium Excretion (mmol/L)			
Variables	**Pre-intervention**		**Post-intervention**	
	High (>220) n = 156	Normal (n≤220) n = 126	High (> 220) n = 106	Normal (≤ 220) n = 174
Study Group				
Salt Taste Thresholds (mmol/l)				
High (≥60)	156 (100.0)	24 (19.0)	99 (93.4)	30 (17.2)
Normal (<60)	0 (0.0)	102 (81.0)	7 (6.6)	144 (82.8)
Statistics	p = 0.000*, kappa = 0.83		X^2 = 153.759, p = 0.000, kappa = 0.73	
Control Group				
	Phase 1		Phase 2	
Salt Taste Thresholds (mmol/l)				
High (≥60)	154 (100.0)	24 (18.8)	130 (93.5)	33 (23.7)
Normal (<60)	0 (0.00)	104 (81.2)	9 (6.5)	106 (76.3)
Statistics	p = 0.000*, kappa = 0.83		X^2 = 139.541, p = 0.000, kappa = 0.70	

Table 4: Relationship between STT and USE among respondents.

*Fisher's exact test applied.

Discussion

The baseline mean urinary sodium excretion (mmol/l) in this study was 210.4 ± 57.2 for the study group and 214.0 ± 62.2 for the control group. These findings were lower than the reported 284.3 ± 23.7 in a hospital based cross-sectional study in Benin, Edo State by Ukoh., *et al.* among offspring of hypertensive patients [23]. The difference might be due to the age group of participants and the higher amount of food consumption among young people to meet up the daily energy requirements. However it was higher than 151.2 ± 22.2 reported in Lagos by Elias., *et al.* among hypertensive subjects [26], and 93.0 ± 52.8 and 149.0 ± 112.6 observed by Forrester., *et al.* in a study conducted among normotensive adults in Igbo-Ora and Idere in Oyo State, Nigeria and neighbourhood of the University of West Indies in Jamaica [27]. It was also higher than 99.9 ± 44.7 and 102.5 ± 45.3 reported for the study and control groups in a community based study done to reduce salt intake and blood pressure by Cappuccio., *et al.* in Ashanti region of central Ghana [28]. These lower values may be due to the different study populations. The mean USE of 111.4 ± 45.4 reported among healthy Australian women by Charlton., *et al.* was also lower than the findings in this study. This may be due to the fact that Australia was among the few countries that had adopted policies aiming at reducing dietary salt intake in the general population [19]. The high USE was a reflection of high sodium intake among the respondents in this study. Post-intervention the USE had reduced to 199.4 ± 48.4 and 211.0 ± 62.2 among the study and control groups respectively and only the reduction among the study group was statistically significant (p = 0.014). This showed that the interventional measure yielded positive result. However the USE was reported to have increased from 151.2 ± 22.2 to 189.8 ± 15.1 and from 125.7 ± 32.4 to 149.6 ± 32.4 among hypertensive and normotensive subjects following increase in salt intake in a study conducted in Lagos by Elias., *et al.* [26].

In this study the mean salt taste threshold (mmol/l) was 47.3 ± 19.7 in the study group and 49.7 ± 20.0 in the control group. The salt-taste sensitivity did not significantly differ between the study and control pre-intervention. These were lower than the 88.8 ± 5.9 reported among the offspring of hypertensive subjects by Ukoh., *et al.* in Benin, Edo State [23]. Benin is an urban city and the capital of Edo state, high intake of processed food is very likely along with great desire and demand for salty foods. The younger age group may also explain this difference. However it was higher than the 41.0 ± 2.9 reported among similar age group hypertensive subjects by Azinge., *et al.* in Lagos [14]. Post-intervention the mean STT had reduced to 42.9 ± 17.7 and 48.6 ± 20.1 among the study and control groups respectively. The observed reduction among the study group was statistically significant (p = 0.006). This showed that the interventional measure yielded positive result.

This study also shows the fact that voluntary reduction in salt intake overtime will bring about significant reduction in the salt-taste threshold, thereby limiting the desire and demand for salty foods. This study also showed that more than three-quarters of respondents with high STT among the study and control groups both pre and post-intervention also had high USE; this was similar to the findings by Azinge., *et al.* [14]. Furthermore this study shows the direct relationship between STT and USE and the fact that either of the two variables could serve as a marker to estimate individuals and population salt intake.

Conclusion

Dietary salt reduction intervention in the study group had a positive influence on the urinary sodium excretion and salt-taste sensitivity. Salt taste sensitivity testing, can be adopted in the Family Medicine clinic to estimate patients' level of salt intake and advise accordingly. Further research needs to be conducted using randomised controlled trial where some other extraneous variables or factors affecting salt taste threshold such as anatomical disruption of taste buds from burns and other injuries, Zinc deficiency and infections (flu, cold) that affect olfaction which in turn affect taste, will be controlled for. The use of overnight urine collection in measuring provided only a crude estimate of short-term salt intake.

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