Estimation of Salt Intake by 24 Hours Urinary Sodium Excretion in Normotensive Subjects of Jaipur City, Rajasthan

Sonal Dhemla
Research Scholar
Department of Home Science
University of Rajasthan, Jaipur
sonaldhemla@gmail.com

Kanika Varma
Associate Professor
Department of Home Science
University of Rajasthan, Jaipur
kanikavarma@gmail.com

Abstract **:-** The prevalence of hypertension has increased dramatically in developing countries like India, where marked changes have occurred in food consumption pattern changing to more western along with traditional which also contributes rich amount of sodium in our cuisines. Given the rising burden of hypertension and high salt consumption, the priority intervention of choice for hypertension prevention and control is population-wide salt reduction. Therefore it's imperative to determine current consumption levels so that appropriate evidence-based preventative public health action can be initiated. Such data is critical in facilitating the development and implementation of an India-specific salt reduction programme. The study was conducted on 30 subjects residing in Jaipur city. Sodium consumption of the subjects was found by using 24 hours urinary sodium excretion, "gold standard" method suggested by WHO/PAHO (2010) and 24 hours dietary recall for three days including one holiday. The findings of the study indicated that the condition is alarming in Jaipur City as subjects are found to be consuming much more of sodium (4474 mg/day in males and 4150.30 mg/day in females) than recommended by WHO, i.e. less than 2300 mg/day. There is an urge need for meaningful strategy to reduce salt intake and it must involve public education and awareness to change the consumption pattern.

Keywords: *sodium, salt, hypertension, coronary heart disease, salt-reduction.*

*****

I. INTRODUCTION

Salt (Sodium Chloride), so ubiquitous in Indian diet, is a major cause of high blood pressure and other heart diseases along with other associated diseases. Majority of the sodium in the region is from added salt, either while cooking or on the table and of course the processed foods, which are now being a major source of sodium in Indian diets. Sodium is also found naturally in a variety of foods, such as milk, egg, fish, meat and much more. High amounts of sodium are also found in many condiments (e.g. soy and tomato sauces). It is often found in high amounts in processed foods such as breads, crackers, processed products and snack foods which are the dominant source of salt. Unrestricted and uninformed use of these processed food items along with traditional and regular cuisine also contributes to the higher salt in India. The rising trend in the consumption of processed food in India has led to a 24-30% prevalence of hypertension in urban areas, and 12-14% in rural areas (Indus Health Plus). Gupta (2004) reported a high prevalence of hypertension in both urban and rural areas. Prevalence rates are almost similar to those in the USA. He reported steadily increasing hypertension prevalence, with reporting prevalence of 10.99% in Jaipur (1995) itself. Salt consumption in developing countries is increasing in parallel with increasing urbanization. There are very few recent epidemiological studies in the country looking at dietary salt intake in relation to prevalence of hypertension in urban India.

An Indian Council of Medical Research (ICMR) survey reported a daily salt intake of 13.8 gram in 13 states in 1986-88 (Kalra et al, 2013). The Chennai Urban Rural Epidemiology Study (CURES) reported a mean dietary salt intake of 8.5 gram//day and a significantly high prevalence of hypertension was noted in high salt consumers (Radhika et al, 2007). The HEART study was initiated in Tamil Nadu and early report indicated a salt intake of 12 g/d (Chidambaram et al, 2012). Jan et al (2006) reported 424±150.50 mmol/d and 337±121.50 mmmol/d as the mean levels of sodium excretion in hypertensive and normotensive respectively in Kashmir may be related to intake of salt tea.

There is clear evidence that too much sodium, mainly in the form of salt (sodium chloride), has adverse implication for health (He and MacGregor, 2009). Sodium intake is associated with elevated blood pressure, which is a leading risk for cardiovascular disease, a major risk factor for premature deaths globally (WHO, 2011). It was reported that of a total of 9.4 million deaths in1990, cardiovascular diseases caused 2.3 million deaths (25 percent). A total of 1.2 million deaths were due to coronary heart disease and 0.5 million due to stroke (Murray and Lopez, 1997). It has been predicted that by 2020, there would be a 111% increase in cardiovascular deaths in India. Control of the predicted increase in cardiovascular disease will require modification of risk factors (Gupta, 2004). The recent global burden of disease study reports excess salt intake to be the 7th leading cause of mortality in South East Asia Region which is much

 ISSN: 2321-8169
113 – 118

higher than in rest of the world (11th globally), highlighting the adverse impact of high intake in countries like India (Lim et al, 2012). The rising burden of hypertension, associated CVD and NCDs in India needs to be addressed as a public health priority employing an optimal context specific resource sensitive combination of the population and the clinical approach. Individuals are often unaware of the detrimental effect of salt on health (Brown et al, 2009). However, its potential has yet to be tapped in India with efforts being initiated only recently.

Sodium reduction is probably the most feasible lifestyle intervention, in part because it can be implemented without substantive change in societal structure or consumer behavior (Penz et al, 2008). Reducing salt intake has never been more relevant than it is today (Dobe, 2013). Efforts should be made to raise public awareness regarding how much sodium they are ingesting and of course the harmful effects of excessive salt intake.

II. METHODS AND MATERIALS

Sampling

Study was conducted in Jaipur city of Rajasthan which is very popular for its diverse food culture and predicted to be high in their sodium content. Thirty normotensive subjects (male and female) in the age group of 25 – 45 years were selected for the purpose through convenience sampling. Those with known history of hypertension, diabetes mellitus, heart or kidney failure, stroke, liver disease or consuming any type of medicine and pregnant/lactating females were excluded.

Before proceeding data collection, approval from ethical committee of the Home Science department, University of Rajasthan, Jaipur was taken for conducting the present study.

Methodology was based on the protocol provided by WHO/PAHO (2010) for estimation of sodium consumption by using 24HUNaE.

General profile of the subjects

A pre tested, semi structured, pre coded questionnaire was developed for the collection of general information of all subjects regarding background characteristics of the respondents i.e. name, age, address, socio-economic status, occupation, food habits and other habits along with information regarding family history of hypertension and related cardiovascular disease.

Anthropometric measurements

Nutritional assessment of the subjects was carried out by conducting anthropometric measurements including height, weight, waist and hip circumferences. Body mass index (BMI) and waist-hip ratio (WHR) were further calculated from observed measurements and then interpreted as per their respective standard cut offs.

Bio-physiological Assessment

It included the blood pressure measurement of the subjects. It was taken by using OMRON HEM-7130, a digital automatic blood pressure monitor. Normal level of systolic blood pressure that was considered is 120 mm of Hg and diastolic blood pressure 80 mm of Hg as given by U.S. Department of Health and Human Services (2004).

Dietary assessment

Information regarding the dietary pattern of subjects was gathered by 24 hour dietary recall for three days including one holiday. The sodium content of these diets was then calculated by using “Dietcal” software (version 5) that was based on “Food Composition Table” as given by Gopalan et al (2012).

Biochemical assessment

Twenty four hours urinary sodium excretion (24HUNaE) of the subjects was carried out which has been advocated by WHO/PAHO (2010) as gold standard method to assess sodium consumption of the population. The benefit of this method is that it provides an objective measure of ingested sodium and is free of reporting bias. Assessments were carried out at clinical laboratory by trained technicians and the secondary data were used for the purpose.

After getting the consent of the respondents, they were instructed about the collection procedure in detail. Respondents were provided with a 1000 ml beaker with a wide opening, a funnel to be used during urine collection and a five liters screw capped plastic bottles-the collection container (without preservative). Respondents were asked to collect all urine passed during a 24 hour period. On the day of collection the subject’s first void was not collected but thereafter all the urine voided was collected including any urine passed during the night and till the first urine of the next day. All the urine was collected in a plastic mug and poured in a storage container of 5 L capacity with the help of a funnel. This was repeated for all subsequent voids. Then the containers were labeled with the respondent’s name, date and time of collection to ensure proper sample collection. During the collection period, participants were instructed to store the storage container in a cool and dark place, away from heat or sun.

Physical activity

Participants completed a questionnaire on their usual physical activity as given by Bharthi et al (2007). This information was used to calculate estimated energy expenditure. The questionnaire assessed physical activity of the past month across multiple domains including discretionary leisure time, household chores, work, sleep, sedentary activities and other common daily activities. The frequency and average duration for each activity were documented. Physical activity patterns can be calculated as

PAL = TEE/ BMR (ICMR, 2010)

where TEE (Total Energy Expenditure) is a sum of energy expenditure of all reported activities computed for a single day. BMR (Basal Metabolic Rate) was calculated by using formula given by ICMR (2010) for age. On the bases of their PAL Scores subjects were categorized into sedentary, moderate and heavy worker as suggested by ICMR (2010).

Statistical analysis

Means and standard deviations were calculated for all variables and the normality of the data was checked. Correlation coefficient was calculated between 24HUNaE and dietary sodium consumption. Correlation coefficient of 24HUNaE with physical activity was also calculated. Student's t test was used to find out the significance difference between 24HUNaE and reported dietary sodium consumption. Test was also carried out to find out the significant difference of dietary sodium consumption depending on the gender.

RESULTS

The subjects were normotensive (10 males and 20 females) with the mean age of 32.8 and 31.33 years respectively. All of them (both males and females) were found to be representing high socio-economic status with high educational as well as professional status and belonged to Hindu religion. Regarding food habits, 7 males (70%) and 16 females (80%) were found to be vegetarian. Subjects that showed positive family history regarding hypertension and other heart disease were 13.33% (n=4) and 16.66% (n=5) respectively in males and in females that was found to be higher i.e. 43.33% (n=13) and 36.66% (n=11) respectively.

The mean values for anthropometric measurements of the subjects were given in table 1. It was depicted that males and females both were found to be overweight and BMI found to be higher in males as compared to females. Waist Hip Ratio for males and females both was found to be within given cut-offs.

The findings of the study indicated that the urinary excretion of sodium was found to be as high as 4474 mg/day in males and 4150.30 mg/day in females (Fig.1). Mean 24HUNaE of males and females were not found to be differing significantly at 5% level of significance. The mean urine volume of the subjects was 1420±523 ml/day and 1510 ±838.88 ml/day for male and female respectively.

Assuming that the Na eliminated in the urine comes from salt, this excretion would correspond with a dietary salt intake of 11.36 gm/day and 10.54 gm/day of salt in male and female respectively. For conversion from sodium to sodium chloride, i.e. salt, a factor 2.54 was used [NaCl (g) = Na (g) * 2.54] as given by German Nutrition Society, Austrian Nutrition Society, Society for Nutrition Research & Swiss Nutrition Association (2002), Ribic et al (2010) and Land et al (2014).

A total of 90 % of the population showed urinary sodium values above the daily sodium intake (100 mmol/day) recommended by WHO (2012). The 24HUNaE as a whole population averaged 4258.23 mg/day (corresponding to a dietary intake of 10.81 g/day of salt) ranging from 1311 mg/day to 7003.5 mg/day.

Most commonly food items that were found to be contributing sodium in their diets were addition of salt during and after cooking. Jaipur, a capital city of Rajasthan, has a rich and diverse dietary culture along with extensive use of salt and spices. Salt is ubiquitous in our curries, salads, namkeens etc reaching extremely high levels in papad & pickles and large quantity of salt consumed is hidden in processed foods. Same trend was also seen in the present study.

Sodium consumption in the diet was calculated by using 24 hours dietary recall method for three days including one holiday. It was reported to be 3910.6 mg/day and 3362.3 mg/day in males and females respectively which was found to be less than the 24 hours urinary excreted sodium. The results showed a linear positive but non-significant correlation (r = 0.103; for males, r = 0.349 and for females r = 0.059) between 24 hours urinary sodium excretion and the reported dietary sodium (Fig.2).

Numerous studies have also shown that people tend to underreport, so again the results are likely to be underestimated. Leiba et al (2005) also reported that patients tend to underestimate their sodium intake by 30% to 50%; therefore, urinary sodium excretion is more accurate to assess sodium intake. Thus, 24-h urinary sodium excretion should be used in clinical practice and in clinical trials, especially when dietary non-compliance is suspected. When mean sodium consumption from discriminatory salt was calculated, it was found to be 2701.067 mg/day. It would mean that 73.83 % of the sodium was directly coming from the salt (NaCl) in regional kitchens (Fig.3).

Blood pressure of the subjects was found to be in the given range for systolic and diastolic both (126/81.5 mm/Hg and 108.6/74.25 mm/Hg in males and females respectively) although they were consuming too much sodium. This was because of inclusion criteria but consumption of too much of sodium can cause health problems with ageing. Systolic blood pressure (r= 0·349) and diastolic blood pressure (r 0·153) correlated positively and but non- significantly with 24 h urinary Na excretion.

Regarding physical activity, 86.66 % of the studied subjects were found to be having sedentary life style (mean PAL= 1.57, range = 1.32 - 2.02). Subjects in the current study were not performing any heavy or vigorous physical activity, so not need to be considered as contributor of sweat losses and thus affecting the urine sodium excretion. When correlation coefficient was calculated with 24HUNaE, a negative non-significant correlation (r = -0.033) was found between two variables.

DISCUSSION

This study presented 24 hours urinary sodium excretion results as a proxy to daily sodium consumption among the normotensive subjects residing in Jaipur city. Use of seasoned foods and the growing use of take-away and packed foods in the urban settlements are likely to be the main contributors of daily salt burden in the region. Pani-puri, chat and aloo tikki were one of them. Bikaneri bhujia which is being consumed in plenty in the region and contributed nearly 900 mg/100 gm. Subjects were consuming this with their regular meal, once or twice a day. Other then these, sodium is found naturally in a variety of foods, such as milk, cereals, egg, fish and meat contributing fair amount of sodium in our cuisines. It is often found in high amounts in processed foods such as breads, crackers, processed breakfast foods and snack foods. High amounts of sodium are also found in many condiments (e.g. soy and tomato sauces). Strict yet practical targets and timelines need to be set for that and adequately monitored and evaluated with defined or inferred consequences as sodium consumption is predicted to being towards higher side because of the diversity of the Indian cuisines, besides the consumption of fast foods. Education and knowledge translation needs to be given to policy makers, health care professionals, and general public and the food industry. It is important to engage and empower NGOs, civil society and health care organizations. For an effective programme, monitoring and evaluation of dietary salt intake, sources of salt in the diet, amounts of salt in food, amount of salt added to food at home as well as knowledge, attitudes and behaviors are required.

As the results of the study indicated that the situation in Jaipur city is found to be indicative of high sodium consumption, there is an urge need for meaningful strategy to reduce salt intake and it must involve public education and awareness to change the consumption pattern.

REFERENCES

1. Bharathi, A.V., Kuriyan, R., Kurpad, A.V., Thomas, T., Ebrahim, S., Kinra, S., Lyngdoh, T., Reddy, S.K., Dorairaj, P. and Vaz, M. Assessment of physical activity using accelerometry, an activity diary, the heart rate method and the Indian Migration Study questionnaire in South Indian adults. Pub. Healt. Nutr., 2009,13(1),47–53.
2. Brown, I.J., Tzoulaki, I., Candeias, V. and Elliott, P. Salt Intakes around the World: Implications for Public Health. Intr. J. Epidemiology. 2009, 38,791-813.
3. Chidambaram, N., Sethupathy, S., Saravanan, N., Taguchi, T., Mori, M. and Garg A. Nutritional factors for hypertension in India; the first report of the heart study based on biological marker estimation of 24-hour urine samples. J. Hypertens. 2012, 1:e49.
4. Dobe, M. Hypertension: The prevention paradox, I.J.P.H. 2013, 57, 1-3.
5. German Nutrition Society, Austrian Nutrition Society, Society for Nutrition Research & Swiss Nutrition Association. Reference Values for Nutrient Intake. Frankfurt am Main: Umschau Braus 2002.
6. Gopalan, C., Ramasastri, B.V. and Balasubramaniam, S.C. Revised and updated by Narasingarao BS, Deasthala YG, Pant RC. Nutritive Value of Indian Foods. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, 2012.
7. Gupta, R. Trends in Hypertension Epidemiology in India. J. Hum. Hypertens. 2004,18,73-78.
8. He, F.J. and MacGregor, G.A. A Comprehensive Review on Salt and Health and Current Experience of Worldwide Salt Reduction Programmes: Salt and Health. J. Hum. Hypertens. 2009, 23,363-384.
9. ICMR. Nutrient Requirements and Recommended Dietary Allowances for Indians. A Report of the Indian Council of Medical Research 2010, National Institute of Nutrition, Hyderabad, India,2010.
10. Indus health plus. Salt consumption and prevention. Available at http://www.indushealthplus.com/salt-consumption-prevention/. Accessed on April 26, 2013.
11. Jan, R.A., Shah, S., Saleem, S.M., Waheed, A., Mufti, S., Lone, M.A. and Ashraf, M. Sodium and potassium excretion in normotensive and hypertensive population in Kashmir. J.A.P.I. 2006, 54, 22-26.
12. Kalra, S., Sahay, M. and Baruah, M.P. Reducing Salt Intake for Healthier World. J. Med. Nutr. and Nutraceuticals. 2013, 2, 1-2.
13. Land, M.A., Webster, J., Christoforou, A., Praveen, D., Jeffery, P., Chalmers, J., Smith, W., Woodward, M., Barzi, F., Nowson, C., Flood, V. and Neal, B. (2014), "Salt intake assessed by 24 h urinary sodium excretion in a random and opportunistic sample in Australia", *BMJ Open*, Vol. 4 No. 1.
14. Leiba, A., Vald, A., Peleg, E., Shamiss, A. and Grossman, E. Does dietary recall adequately assess sodium, potassium and calcium intake in hypertensive patients? Nutri. 2005, 21(4), 462-6.
15. Lim, S.S., Vos, T., Flaxman, A.D., Danaei, G., Shibuya, K., Adair-Rohani, H., Amann, M., Anderson, H.R., Andrews, K.G., Aryee, M., Atkinson, C., Bacchu, L., Bahalim, A.N., Balakrishna, K., Balmes, J., Barker-Collo, S., Baxter, A., Bell, M.L., Blore, J.D., Blyth, F., Bonner, C., Borges, G., Bourne, R. and et al. A

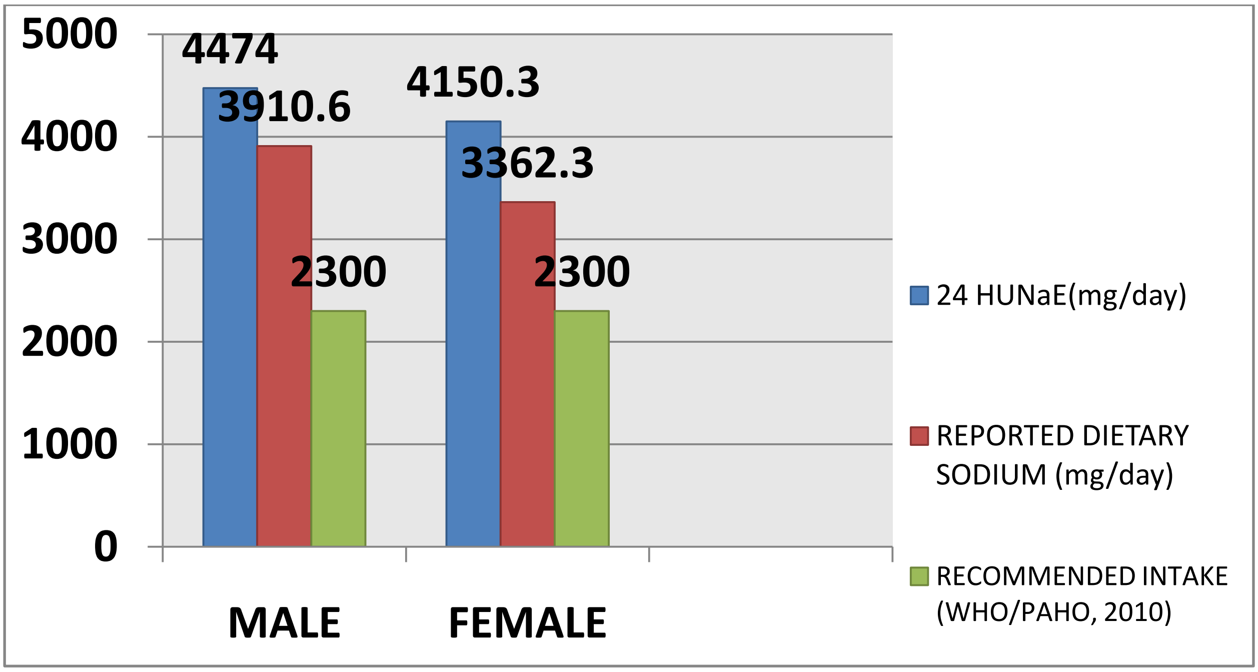
comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systemic analysis for the global burden of disease study 2010. The Lancet. 2012, 380, 2224-2260.

16. Murray, C.J.L. and Lopez, A.D. Mortality by Cause for Eight Regions of the World: Global Burden of Disease Study. Lancet. 1997, 349, 1269-1276.
17. Penz, E.D., Joffres, M.R. and Campbell, N.R. Reducing dietary sodium and decreases in cardiovascular disease in Canada. Can. J. Cardiol. 2008, 24,497-501.
18. Radhika, G., Sathya, R.M., Sudha, V., Ganesan A. and Mohan V. Dietary Salt Intake and Hypertension in an Urban South Indian Population [CURES-53].J.A.P.I. 2007, 55, 405-411.
19. Ribic, C.H., Zakotnik, J.M., Vertnik, L., Vegnuti, M. and Cappuccio, F.P. (2010), "Salt intake of the Slovene population assessed by 24 h urinary sodium excretion", *Public Health Nutrition*, Vol. 13 No. 11, pp. 1803-1809.
20. U.S. Department of Health and Human Services. Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. The Seventh Report of the Joint National Committee, 2004, 1-140.
21. WHO. Global Status Report on Non-communicable Diseases 2010: Description of the Global Burden of NCDs, their Risk Factors and Determinants 2011, World Health Organization 2011.
22. WHO. Population Sodium Reduction Strategies for Prevention and Control on Non-communicable Diseases in the South-East Asia Region, Report of the Regional Meeting, New Delhi, India. 11–13 December 2012, Regional Office of South-East Asia, World Health Organization 2012.
23. WHO/PAHO. Regional expert group for cardiovascular disease prevention through population-wide dietary salt reduction. Protocol for population level sodium determination in 24 hour urine samples. 2010:1-40.

Tables and figures:

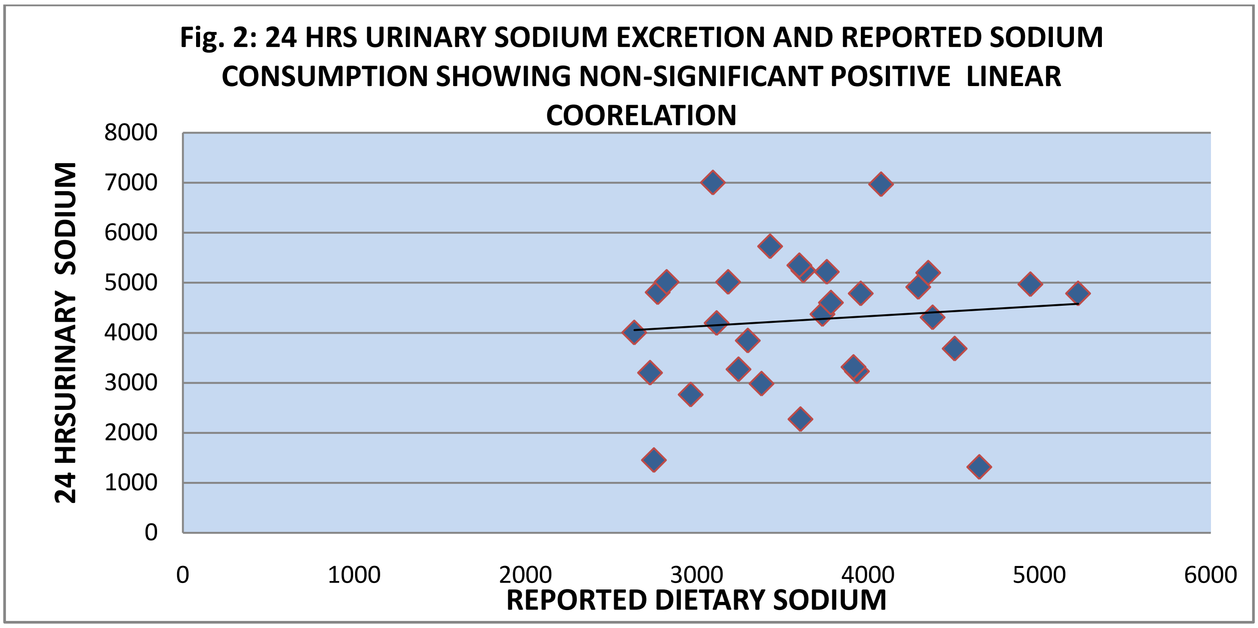
Table 1: Mean values for Anthropometric measurements

Anthropometric measurements	Mean values For males	Standard Deviation	Mean values For females	Standard Deviation
Weight (kg)	81.29	±7.08	69.04	±10.18
Height (cm)	172.36	±9.10	160	±9.10
BMI (kg/m^2)	27.34	±2.71	25.43	±3.51
WHR	0.91	±0.04	0.84	±0.05



ISSN: 2321-8169
113 – 118

Fig.1: Mean reported dietary sodium intake and 24HUNaE



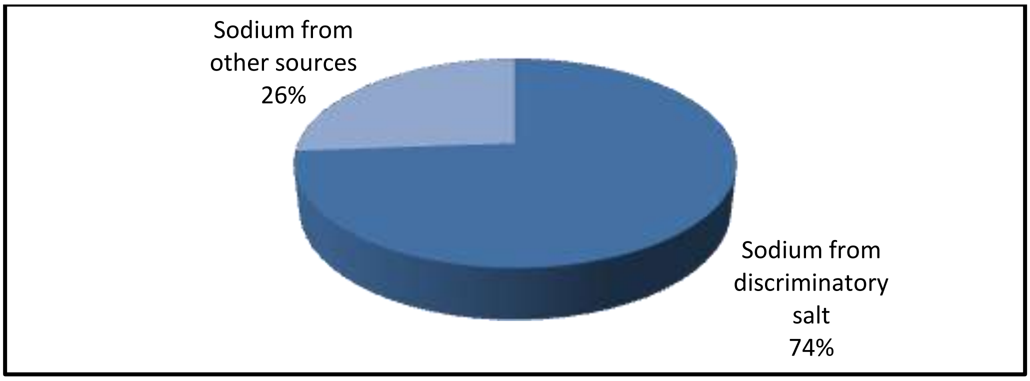


Fig.3: Sodium contributed by discriminatory salt in regional kitchens