

Study of association between 24 hours urinary sodium & potassium excretion and blood pressure at a tertiary hospital

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Abstract

Background: Hypertension is a very common disorder especially past middle age. It is not a disease in itself, but is an important risk factor for coronary, cerebral, renal and peripheral vascular disease. Present study was aimed to study association between 24 hours urinary sodium & potassium excretion and blood pressure at a tertiary hospital. **Material and Methods:** Present study was prospective, comparative study, conducted in cases (patients of age between 18 and 75 years, diagnosed with hypertension) & controls (same age and sex, normotensive subjects). **Results:** We compared 40 cases with 40 age & gender matched controls. There was no statistically significant difference observed in age, gender & BMI ($p > 0.05$). There was a statistically significant difference noted in serum cholesterol (193 ± 14.768 vs 183.15 ± 13.275 , p value 0.0024) & average serum sodium (140.43 ± 4.031 vs 138.28 ± 2.837 , p value 0.007) among cases & controls. The mean 24 hour urinary sodium excretion was higher in patients with moderate to severe hypertension (178.689 ± 13.039) when compared to subjects with mild hypertension (163.636 ± 13.002) which was statistically significant. (p value 0.002). There was a significant increase in 24 hour urinary sodium excretion in patients with moderate to severe diastolic hypertension (183.33 ± 15.282) as compared to patients with mild diastolic hypertension (169.28 ± 11.433) (P value 0.002). **Conclusion:** In hypertensive group, there was significantly elevated 24 hour urinary sodium excretion and Na^+/K^+ molar ratio whereas there was lower 24 hour urinary potassium excretion. 24 hour urinary sodium excretion also correlated with severity of hypertension.

Keywords: hypertension, urinary sodium excretion, Na^+/K^+ molar ratio, cardiovascular disease

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Introduction

Hypertension is a very common disorder especially past middle age. It is not a disease in itself, but is an important risk factor for coronary, cerebral, renal and peripheral vascular disease. ⁽¹⁾ Of all hypertensive patients, majority of cases are of essential hypertension which accounts for about 90% of total hypertensive population.¹

Risk factors for hypertension incidence include genetic predisposition, age, sex, BMI, smoking, alcoholism and lifestyle factors. Among lifestyle factors, high dietary sodium and low potassium intakes were found to be associated with blood pressure in many studies.^{2,3}

The large Intersalt study showed that high sodium intake was directly related to blood pressure while potassium intake was inversely and independently related to the same.⁴ A positive correlation was observed between urinary Na^+/K^+ molar ratio and blood pressure.⁴ Also, increased blood pressure is required to maintain renal sodium excretion and sodium balance in essential hypertension.⁵ Present study was aimed to study association between 24 hours urinary sodium & potassium excretion and blood pressure at a tertiary hospital

Material And Methods

Present study was prospective, comparative study, conducted in department of general medicine, at Government Rajaji Hospital, Madurai, Tamilnadu, India. Study duration was of 8 months (April 2012 - November 2012). Study approval was obtained from institutional ethical committee.

Inclusion criteria

- Cases - Patients of age between 18 and 75 years, diagnosed with hypertension, willing to participate in present study
- Controls - Same age and sex, normotensive (BP lower than 140/90 mmHg) subjects, willing to participate in present study

Exclusion criteria

- Patients with secondary hypertension.
- Patients on NSAIDs, anti-hypertensives, diuretics.
- Patients with congestive cardiac failure.
- Patients with malignant hypertension.
- Females on oral contraceptive medications.

We compared two groups – Hypertensives and Normotensives, equal number of age and sex matched controls were taken up for study. An informed written consent was obtained from all the subjects included in the study. Hypertension was defined as per JNC VI report⁶- BP – 140/90 mmHg least at three different occasions after refraining from anti-hypertensives and diuretics for at least three weeks before the study, refraining from eating, smoking or indulging in any stressful activity 30 minutes before recordings.

A detailed medical history was obtained from all the subjects. Family history of hypertension, Diabetes mellitus, cardiovascular disease and renal disease were sought. Duration of hypertension, levels of elevated blood pressure, results and side effects of anti-hypertensive therapy were recorded. History of all the prescribed and over the counter medications, smoking, alcohol use, weight gain and symptoms suggestive of secondary hypertension were obtained.

A complete physical examination was conducted for all the subjects which included pulse and BP measurements, examination for edema, distended veins, thyromegaly, examination of cardiovascular, respiratory, abdominal and central nervous systems, optic fundoscopic examination for any hypertensive changes. Height and weight were measured and Body mass Index was calculated as $\text{weight in kg}/\text{height in m}^2$.

Blood pressure was measured on three different occasions with same standard mercury sphygmomanometer in both supine and standing positions. The average of three readings was used in data analysis. All patients underwent investigations such as complete hemogram, Urine analysis, Serum investigations (urea, creatinine, calcium, phosphorus, uric acid, cholesterol, sodium and potassium), 24 hours urinary sodium and potassium excretion. Na^+/K^+ molar ratio, Thyroid profile, USG abdomen and pelvis, Chest X ray, Electrocardiogram, Echocardiography.

24 hour urine collection was done in our study group to measure urinary sodium and potassium excretion. All the participants were instructed to collect urine for 24 hours and not

to alter their dietary pattern during collection so that the urinary sodium and potassium excretion amount was a direct measure of sodium and potassium intake of the individuals.

Statistical analysis was performed using statistical software Medcalc version 12.3 for Windows. P value <0.05 was considered significant. Baseline characteristics between cases and controls were compared using student t test for quantitative variables and chi square test for qualitative variables. Relationship between different variables were analysed by partial correlation after controlling for potential confounders (age,sex&BMI). The different trends in sodium and potassium excretion depending upon age group, BMI and severity of hypertension were analysed using ANOVA.

Results

We compared 40 cases with 40 age & gender matched controls. There was no statistically significant difference observed in age, gender & BMI ($p > 0.05$). The mean systolic blood pressure among cases was 166.55 ± 10.564 while the mean systolic blood pressure among controls was 115.75 ± 5.995 , difference was highly significant (p value < 0.0001). The mean diastolic blood pressure among cases was 98.20 ± 4.525 while the mean diastolic blood pressure among controls was 77.70 ± 4.784 , difference was highly significant (p value < 0.0001).

Table 1: General characteristics

	Cases	Controls	P value
Mean age (mean \pm SD)	49.73 \pm 10.698	47.43 \pm 10.406	0.3328
Gender			
Male	22 (55 %)	20 (50 %)	0.8228
Female	18 (45 %)	20 (50 %)	
BMI			
< 25	24 (60 %)	31 (77.5 %)	0.096
\geq 25	16 (40 %)	9 (22.5 %)	
Total	24.3 \pm 2.445	23.47 \pm 1.894	
Blood pressure			
Systolic BP	166.55 \pm 10.564	115.75 \pm 5.995	<0.0001
Diastolic BP	98.20 \pm 4.525	77.70 \pm 4.784	<0.0001

There was a statistically significant difference noted in serum cholesterol (193 ± 14.768 vs 183.15 ± 13.275 , p value 0.0024) & average serum sodium (140.43 ± 4.031 vs 138.28 ± 2.837 , p value 0.007) among cases & controls. There was no statistically significant difference noted in serum potassium (3.90 ± 0.387 vs 3.79 ± 0.287 , p value 0.126), mean serum calcium (9.59 ± 0.534 vs 9.440 ± 0.605 , p value 0.2433), mean serum phosphorus (3.755 ± 0.295 vs 3.68 ± 0.272 , p value 0.2409), mean blood sugar (103.90 ± 9.9403 vs 102.45 ± 6.2468 , p value 0.4371), mean serum uric acid (5.958 ± 0.5514 vs 5.775 ± 0.7027 , p value 0.2001), mean serum urea (36.20 ± 6.603 vs 34.48 ± 7.46 , p value 0.2769) & mean serum creatinine (0.98 ± 0.281 vs 0.92 ± 0.267 , p value 0.2920).

Table 2: Laboratory investigations

	Cases	Controls	p value
Serum cholesterol	193 \pm 14.768	183.15 \pm 13.275	0.0024*
Electrolytes			
Serum Na	140.43 \pm 4.031	138.28 \pm 2.837	0.007*
Serum K	3.90 \pm 0.387	3.79 \pm 0.287	0.127
Serum calcium	9.590 \pm 0.534	9.440 \pm 0.605	0.2433
Serum phosphorus	3.755 \pm 0.295	3.680 \pm 0.272	0.2409

Blood Sugar	103.90 ± 9.9403	102.45 ± 6.2468	0.4371
Renal function test			
Serum Uric acid	5.958 ± 0.5514	5.775 ± 0.7027	0.2001
Serum Urea	36.20 ± 6.603	34.48 ± 7.463	0.2769
Serum Creatinine	0.98 ± 0.281	0.92 ± 0.267	0.2920

(* - statistically significant)

The mean 24 hour urinary sodium excretion in the hypertensive group was 174.550 ± 14.551 while the mean 24 hour urinary sodium excretion in the normotensive group was 154.425 ± 17.279 . P value was <0.0001 which was highly significant. The mean 24 hour urinary potassium excretion in the hypertensive group was 52.85 ± 7.343 while the mean 24 hour urinary potassium excretion in the normotensive group was 54.93 ± 7.797 . P value was 0.2242 which was not significant.

Table 3: Urinary sodium & potassium excretion

	Cases	Controls	P value
Urinary Na ⁺ excretion	174.550 ± 14.551	154.425 ± 17.279	<0.0001
Urinary K ⁺ excretion	52.850 ± 7.343	54.925 ± 7.797	0.2242
Na ⁺ K ⁺ molar ratio	3.36:1	2.87:1	<0.0001

In the hypertensive group, 11 subjects had mild hypertension and 29 subjects had moderate to severe hypertension. The mean 24 hour urinary sodium excretion was higher in patients with moderate to severe hypertension (178.689 ± 13.039) when compared to subjects with mild hypertension (163.636 ± 13.002) which was statistically significant. (p value 0.002) The average 24 hour urinary potassium excretion was higher in patients with moderate to severe hypertension (54.038 ± 7.476) when compared to subjects with mild hypertension (49.727 ± 6.247) which was statistically insignificant. (p value 0.098).

Table 4: Relationship of 24 hours urinary sodium and potassium excretion with severity of systolic hypertension

Group	Severity of systolic hypertension				P value
	Mild		Moderate to Severe		
	No	Mean ± S.D	No	Mean ± S.D	
Urinary sodium excretion	11	163.636 ± 13.002	29	178.689 ± 13.039	0.002
Urinary potassium excretion	11	49.727 ± 6.247	29	54.038 ± 7.476	0.098

There was a significant increase in 24 hour urinary sodium excretion in patients with moderate to severe diastolic hypertension (183.33 ± 15.282) as compared to patients with mild diastolic hypertension (169.28 ± 11.433) (P value 0.002). The average 24 hour urinary potassium excretion in patients with mild diastolic hypertension (51.92 ± 7.729) was comparable to patients with moderate to severe diastolic hypertension (54.4 ± 6.609), difference was not statistically significant (p value 0.307).

Table 5: Relationship of 24 hour urinary sodium and potassium excretion with severity of diastolic hypertension

Group	Severity of diastolic hypertension				P value
	Mild		Moderate to Severe		
	No	Mean \pm S.D	No	Mean \pm S.D	
Urinary sodium excretion	25	169.28 \pm 11.433	15	183.33 \pm 15.282	0.002
Urinary potassium excretion	25	51.92 \pm 7.729	15	54.4 \pm 6.609	0.307

In hypertensive patients, the partial correlation co-efficient 'r' was 0.6372 and p value was less than 0.0001 for correlation between 24hour urinary sodium excretion and systolic blood pressure, which was statistically significant. The partial correlation co-efficient 'r' was 0.5310 and p value was 0.0009 for correlation between 24 hour urinary sodium excretion and diastolic blood pressure, which was statistically significant.

There was significant correlation between 24 hour urinary K⁺ excretion (r = -0.3547, p = 0.0338) and systolic blood pressure while there was no significant correlation between diastolic blood pressure and 24 hour urinary K⁺ excretion (r=0.1001, p=0.561) in hypertensive patients.

Table 6: Correlation between blood pressure and 24 hour urinary sodium excretion in hypertensives after adjusting for confounding factors

Hypertensives	Systolic BP		Diastolic BP	
	r	p	r	p
Urinary sodium	0.6372	<0.0001	0.5310	0.0009
Urinary potassium	-0.3547	0.0338	0.1001	0.5615

Discussion

Hypertension is one of the world's great public health problems and leading cause of death. Essential hypertension accounts for about 90% of all hypertensive patients.⁷ Multiple factors are responsible for the development of hypertension. One of the causal factors proposed is high sodium intake along with low potassium intake and excretion.²

In our study, the mean 24 hour urinary sodium excretion was significantly elevated in hypertensive group when compared to normotensive group which was statistically significant (p value <0.0001). Our observation was similar to that recorded in the Intersalt study.³ Many other studies have shown excessive 24 hour urinary sodium excretion in hypertensive patients.^{8,9}

Excessive 24 hour urinary sodium excretion observed in hypertensive patients in our study could probably be responsible for the development of hypertension which was proved in various other studies.^{2,7,9} This was further supported by the fact that low salt intake reduces hypertension and low prevalence of hypertension in population with low salt intake.^{10,11}

In our study, the average 24 hour urinary potassium excretion was lower in both hypertensive and normotensive groups probably due to low potassium intake. Various other studies have also confirmed that low potassium intake leads to hypertension, independent of sodium excretion.^{12,13}

Excessive 24 hour urinary sodium excretion and lower 24 hour urinary potassium excretion in our hypertensive group indicates that both high sodium intake and low potassium intake additively contribute to the rise in blood pressure. Further urinary Na⁺/K⁺ molar ratio

was higher in hypertensive groups when compared to normotensives which was due to increased urinary sodium excretion in hypertensive group as shown in various other studies.³

Our study observed significant influence of 24 hour urinary sodium excretion on the severity of hypertension. The mean 24 hour urinary sodium excretion was significantly higher in patients with severe hypertension as compared to mild to moderate hypertension which was statistically significant (p value = 0.002). There was no association between 24 hour urinary potassium excretion and severity of hypertension. Similar observations were also recorded by RA Jan et al.,³

Simpson et al.,¹⁴ found that mean 24 hour urinary sodium excretion at all ages was significantly higher in males when compared to females. Similar results were obtained in our study which showed a higher 24 hour urinary sodium excretion in males as compared to females at all age groups. This could be probably because of their overall higher food intake and differences in food habits.^{15,16,17,18}

Our study demonstrated a significant impact of BMI on 24 hour urinary sodium excretion. In both hypertensive and normotensive groups, 24 hour urinary sodium excretion increased significantly with high BMI. There was no association between urinary potassium excretion and BMI in either group. Intersalt study has shown significant and independent relationship of BMI with hypertension in individual subjects³ which was proved in our study. Simpson et al.,¹⁴ also proved similar relationship of BMI with urinary sodium excretion and hypertension as observed in our study.

In our study, the next factor independently associated with blood pressure was serum cholesterol, which has been proved beyond doubt as an independent risk factor for hypertension.¹⁹ The relationship of 24 hour urinary sodium and potassium excretion with blood pressure was analysed again after controlling for the confounding factors.

In hypertensive patients, systolic blood pressure correlated significantly with 24 hour urinary sodium excretion ($r = 0.64$, $p < 0.0001$) and 24 hour urinary potassium excretion ($r = -0.35$, $p = 0.033$) even after adjustment for age, gender, BMI, serum cholesterol. In normotensive controls, systolic blood pressure does not correlate with 24 hour urinary sodium excretion ($r = 0.02$, $p = 0.92$) and potassium excretion ($r = 0.19$, $p = 0.25$).

In hypertensive patients, diastolic blood pressure correlated with urinary Na^+ excretion ($r = 0.53$, $p = 0.0009$) but did not correlate with urinary K^+ excretion ($r = 0.10$, $p = 0.56$) after adjustment for age, sex, BMI and serum cholesterol. Similar observation was made by B. M. Y. Cheung et al.,²⁰ in Chinese population. In normotensive controls, diastolic blood pressure did not correlate with urinary Na^+ excretion ($r = 0.22$, $p = 0.19$).

Hypertension is a silent killer, because people who have it are often symptom free or unaware of the disease. There is a need for strengthening adoption of certain interventional measures in lifestyle such as reducing salt intake, weight reduction and promoting physical activity among this vulnerable group should be encouraged. Once identified, elevated BP should be monitored at regular intervals because it is a lifelong disease.

Conclusion

In hypertensive group, there was significantly elevated 24 hour urinary sodium excretion and Na^+/K^+ molar ratio whereas there was lower 24 hour urinary potassium excretion. 24 hour urinary sodium excretion also correlated with severity of hypertension. Age, gender, BMI and serum cholesterol had significant influence on 24 hour urinary sodium excretion.

Even after adjustment for age, gender, BMI and serum cholesterol, 24 hour urinary sodium excretion significantly correlated with both systolic and diastolic blood pressure in hypertensive patients. 24 hour urinary potassium excretion correlated only with systolic blood pressure after adjustment for age, gender, BMI and serum cholesterol. Long term reduction in

salt intake would significantly reduce the prevalence of hypertension and thereby decrease associated morbidity and mortality due to cardiovascular disease and stroke.

Conflict of Interest: None to declare

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