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ORIGINAL ARTICLE

SERUM AND URINARY ELECTROLYTES LEVEL IN THE SUBJECTS OF TWO DIFFERENT ENVIRONMENTAL CONDITIONS

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The serum electrolytes, Sodium and Potassium are the important macronutrient to the human and it is supplied to the body via the solid and liquid food materials. These electrolytes have different roles in the body and these functions are crucial for life. Its rate of consumption and excretion may vary to the different geographical region, and this may cause the variable medical fitness. We investigated the serum & urinary profile of Na^+ & K^+, and compared it with their dietary intake of these macronutrients in 400 healthy subjects from two different regions, plain and hill. The subjects from the plain region consume more Na^+ & K^+ rather than hill region. The Serum & urinary profile of Na^+ & K^+ were observed higher in plain region and it may be the cause of their higher blood pressure as compared to the hill subjects.

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The serum electrolytes, Sodium and Potassium are the important macronutrient to the human and it is supplied to the body via the solid and liquid food materials. These electrolytes have different roles in the body and these functions are crucial for life. Its rate of consumption and excretion may vary to the different geographical region, and this may cause the variable medical fitness. We investigated the serum & urinary profile of Na^+ & K^+, and compared it with their dietary intake of these macronutrients in 400 healthy subjects from two different regions, plain and hill. The subjects from the plain region consume more Na^+ & K^+ rather than hill region. The Serum & urinary profile of Na^+ & K^+ were observed higher in plain region and it may be the cause of their higher blood pressure as compared to the hill subjects.

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Sodium and Potassium are the most important minerals essential to the body, which is consumed as food items. In our body, about 50% of Na^+ is in extra cellular fluids and 40% is in the skeletal tissue, and approximately 10% is within the cells. Like Na^+ the body contains approximately 5% K^+, and the majority (95%) is found in intracellular (inside the cell) fluid and lean body tissue. Na^+ and K^+ function together in an electrogenic system in the body called the Na^+/ K^+ pump. This "pump" is used to transfer nutrients across cells, for muscle contraction and relaxation, and nerve action. The body needs to keep these two minerals in balance because they work opposite of each other. Na^+ and

K^+ have a relationship with blood pressure as well. If the content of Na^+ in the blood is high, this may affect water balance and may raise blood pressure. Na^+ is mostly found in the form of Na^+ chloride (40% of salt is Na^+, 60% is chloride) in food, that include salt, processed meats, canned soups and snack foods. The source of K^+ includes oranges, bananas, tomatoes, dried beans, milk and dried fruits. The Na^+ consumed through diet is absorbed in the gut and carried in the blood to the kidneys where it is filtered out, and returned to the blood in amounts our bodies need for functions. Like Na^+, K^+ absorption is also very efficient in the body but, It mostly occurs in the small intestine. The kidneys regulate K^+ balance, and excessive K^+ may result from kidney injury. The kidneys have a regulated mechanism for reabsorbing Na^+ in the distal nephron and excretion of K^+ ions. This mechanism is controlled by aldosterone, a steroid hormone produced by the adrenal cortex. Aldosterone promotes the excretion of K^+ ions and the reabsorption of Na^+ ions. The release of Aldosterone is initiated by the kidneys. The reabsorption of Na^+ ions is followed by the reabsorption of water. This causes blood pressure as well as blood volume to increase (Guyton *et al*, 2006; Ganong *et al*, 2003).

The present study is an approach to compare the homeostasis of Na^+ & K^+ in relation to variation in environmental parameter of the two totally different geographical cluster i.e. Aizawl (hill) in Mizoram, India and Varanasi (plain) in Uttar Pradesh, India.

Materials and methods

A dietary survey questionnaire was prepared and distributed to 200 healthy individuals (Total 400) each from both sampling stations. The questionnaire consists of epidemiological, meteorological, anthropometric, dietary and laboratory data. Each individual was interviewed for the relevant information as per questionnaire. The anthropometric measurement was taken for height, weight and blood pressure, then accordingly body mass index was calculated. Random urinary and blood samples were collected to analyze the main electrolyte components i.e. Na^+ and K^+.

The dietary data were collected using Dietary Recall Method. Dietary questionnaire describes the daily intake of food items in terms of quantity. Information on food habits, like and dislike, quantity of water and extra salt intake was recorded. The calculation of nutrient value of daily intake of diet was performed as per the chart provided by National Institute of Nutrition, Hyderabad and recommended by Indian Council of Medical Research, for determination of intake quantity of electrolytes and nutrients (Gopalan *et al*, 1987). The dietary data collected was analyzed to calculate the nutrient and electrolyte intake, which included carbohydrate, protein, fat, minerals, crude fiber and energy. Electrolyte intake included Na^+, K^+, calcium, chloride, iron and phosphorous. The body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters.

The analysis of urinary and serum electrolytes was carried out in auto-analyzer for Na^+ & K^+ using ion selective electrode measurement (Jankunas *et al*, 2002).

The Data were analyzed by Sigma stat version 3.5 Software. Mean and standard deviation were calculated for baseline variables in both the groups. The variation of values between two sites was tested to determine whether it differed significantly from zero, using Student's *t*-test. All the tests were two sided, and results were considered statistically significant at p value <0.05.

Table 1. Epidemiological, anthropometrical and electrolytic parameters of subjects

Parameter	Aizawl	Varanasi	*p* value
Number of subjects	200	200	-
Age	43.53 ± 9.41	44.22 ± 12.22	0.527
Height (in meter)	1.64 ± 0.09	1.66 ± 0.16	0.063
Weight (in Kg)	58.02 ± 11.22	66.06 ± 11.68	<0.001
Body Mass Index (%)	21.70 ± 3.98	23.97 ± 3.69	<0.001
Systolic BP (in mm Hg)	115.35 ± 13.58	131.09 ± 18.39	<0.001
Diastolic BP (in mm Hg)	71.52 ± 10.10	83.07 ± 13.51	<0.001
Sodium Intake (in gm)	183.50 ± 106.03	326.47 ± 18.02	<0.001
Potassium Intake (in gm)	2589.59 ± 1615.47	3475.19 ± 1141.74	<0.001
Urinary Sodium (in meq/l)	131.07 ± 51.25	134.98 ± 68.85	0.52
Urinary Potassium (in meq/l)	32.20 ± 16.44	42.64 ± 30.44	<0.001
Serum Sodium (in meq/l)	137.92 ± 13.82	143.58 ± 26.26	0.007
Serum Potassium (in meq/l)	3.82 ± 0.91	4.19 ± 1.01	<0.001

All the data are presented as mean ± standard deviation.

Results

Over all 400 individual were included in the present study. The Gender ratio at both stations in the study represents high male female ratio of 3:1. There were no statistical significant difference was recorded in the age and height of individual from both sites. The Aizawl (hill) individuals have shown statistically significant low body weight and body mass index in relation to Varanasi individual ($p<0.001$). The systolic and diastolic blood pressure of Varanasi individual was found high and it was statistically significant ($p<0.001$).

The daily dietary intake of Na^+ and K^+ through food items was observed statistically high in Varanasi individuals in comparison to Aizawl individuals ($p<0.001$). The Varanasi individuals have shown increased urinary $Na^+$and K^+ excretion as compare to Aizawl individual. However the increase in urinary $Na^+$was statistically non significant ($p= 0.52$), whereas urinary K^+ was found to be highly significant ($p<0.001$). In serum only K^+ was significantly higher amongst the residence of Varanasi. (Table 1)

The table-1 represents, the baseline data of age, height, weight, body mass index, blood pressure (systolic and diastolic), urinary and serum Na^+ & K^+ profile of healthy individuals from Aizawl and Varanasi.

Discussion

The result of above study reveled that, the altitude and variation in environmental condition play very important role in serum electrolyte and urinary electrolyte excretion. The height, weight, body mass index of the individual participated in the study were similar to the previous Indian studies. The BMI (%) observed in Aizawl individual range from 15 to 43, whereas in Varanasi it was 12 to 32. The reason of high BMI in Varanasi may be due to higher intake of carbohydrate and the variation in work profile. Similar type of Indian study has been conducted on three groups of male soldiers at different climatic conditions. The study result showed significant difference in body fat content of three groups, which could be an adaptive feature to the environment (Amitabh *et al*, 2009). Another Wardha based Indian study on rural population have shown strong correlation between BMI and waist circumference with systolic and diastolic blood pressure (Deshmukh *et al*, 2006) and a similar pattern has been observed in present study.

The systolic and diastolic blood pressure was correlated to know the relation of BMI with blood pressure. The results of systolic blood pressure in Aizawl range observed was from 90 to 190 and in Varanasi, it was from 103 to 176. The diastolic blood pressure in individuals from Aizawl region ranges from 45 to 120 in relation to Varanasi, which ranges from 60 to 110. This variation could be a reflection of high Na^+ content in the diet of Varanasi with high body mass index and relatively low excretion of Na^+ in urine. Similar study from Turkey aimed to evaluate the blood pressure of children lived at three different altitude have shown that, a difference of 1700 meter altitude was associated with higher SBP and DBP levels in children with similar demographic characteristics and at this altitude BMI and BP showed a positive correlation (Arslan *et al*, 2003). In an another study from Turkey, the relationship between BMI and blood pressure was evaluated, that reveals that there is a strong association between both systolic and diastolic blood pressure with BMI. The finding suggested the obesity is a strong risk factor in causing hypertension (Gundogdu, 2008). In a study of three populations in Africa and Asia demonstrated that BMI is closely associated with blood pressure in countries at different stages of socioeconomic and epidemiological transition (Tesfaye *et al*, 2007).

In Aizawl region the daily dietary intake of Na^+ was in the range from 10 to 568 gram and in Varanasi, it was from 92 to 658 gram. The chief source of Na^+ is salt and processed meat. In Varanasi amongst vegetarian it was observed that extra salt intake in addition to processed food is high as compare to Aizawl region, where people are used to consume the boiled food. This may be the basic reason of more dietary Na^+ intake in individual from Varanasi as compared to individuals from Aizawl. The dietary K^+ intake was also observed high in Varanasi range from 1220 to 7466 gram in relation to Aizawl that ranges from 103 to 8034 gram. Fruits and vegetables, which are the rich source of K^+ that include leafy green vegetables, fruit and root vegetables. In Varanasi region predominously Hindu observe many festivals throughout the year and these festivals are celebrated by fasting with a fruit based diet, which is K^+ rich. Whereas in Aizawl region of my study the individual are usually non-vegetarian, where the main food is pork, beef and meat. This may be the reason of low dietary K^+ intake in individual from Aizawl area.

The urinary Na^+ excretion was observed high in Varanasi individual range from 23 to 360 meq per liter as compare to Aizawl range from 27 to 316 meq per liter. The reason for high urinary Na^+ may be the increased dietary salt, Body mass index and the variation in environmental condition such as temperature, humidity and rain fall. A study conducted in USA did not show positive correlation between the dietary Na^+ and blood pressure in vegetarian and non-vegetarian (Armstrong *et al*, 1979). Whereas the individuals from Varanasi have shown high urinary K^+ excretion in the range from 2.8 to 140 meq per liter in relation to Aizawl ranging from 2.4 to 65 meq per liter. This variation could be due to the high K^+ intake in the diet of residents of Varanasi. Similar type of study was conducted in China to examine the association of dietary Na^+ & K^+ intake on urinary Na^+ & K^+ excretion. The study results conclude that Western vegetarian diet of high Na^+ predispose the problem of hypertension (Kwok *et al*, 2003). A study conducted among Japanese confirmed the positive link of Na^+ and negative link of K^+ to blood pressure (Kihara *et al*, 1984).

The mean value of serum Na^+ level was high in Varanasi ranging from 96 to 310 meq per liter, whereas in Aizawl individual, it was in the range of 24 to 158 meq per liter. The high serum Na^+ could be contributing factor of high blood pressure in subjects from Varanasi. The serum K^+ level observed in Varanasi subject was high range from 2.6 to 7.9 meq per liter in relation to Aizawl range from 1.4 to 8 meq per liter. The reason of increased K^+ level in serum may be due to the increased dietary K^+ intake in Varanasi subjects. Similar study was conducted in three geographical locations i.e. Austria, Brazil and China that reveals that regional difference in K^+ intake leads to differences in serum K^+ value **(**Reidenberg et al, 1993).

Conclusion

This study reveals that the subjects from the plain region have high BMI, higher dietary electrolyte intake and increased electrolyte in serum & urine. This has reflected in the form higher blood pressure in plain region subjects as compared to hill subjects. We can conclude that the people from plain region have higher blood pressure than hill due to different dietary habits, religious values and lesser workouts.

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