Comparison of Serum Sodium and Potassium level in subjects from Hill and Plain environment

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ABSTRACT

Electrolytes such as Sodium and Potassium are the important macronutrient to the human diet. These electrolytes have different roles in the body and their functions are crucial for life. These both electrolytes functions together in an electrogenic system to transfer nutrients across cells, nerve action and for muscle contraction and relaxation. Their consumption and urinary excretion rate may vary in the different geographical region, which may cause the variable medical fitness. The present study was aimed to compare the homeostasis of sodium & potassium in relation to variation in environmental parameter of the two totally different geographical clusters i.e. Aizawl (hill) and Varanasi (plain). The body mass index and dietary sodium, potassium intake of plain subjects (Varanasi) was significantly higher than the hill subjects (Aizawl), which has resulted higher blood pressure and serum sodium, potassium in plain subjects as compare to hill subjects. The same pattern was observed in urinary sodium and potassium excretion at both sites. Therefore we can conclude that the population in hill-region has a significant preventive role in reducing BMI and blood pressure in relation to population from plain region.

Key Words: Serum Sodium, Serum Potassium, Environment, Minerals, Electrolytes.

Introduction

Sodium and Potassium are the most important minerals essential to the body, which is acquired by several food items. In our body, about 50% of sodium is in extra cellular fluids and 40% is in the skeletal tissue. Like sodium the body contains approximately 50% potassium, and the majority (98%) is found in intracellular fluid and lean body tissue. Sodium and potassium function together in an electrogenic system in the body called the Sodium/potassium pump. This "pump" is used to transfer nutrients across cells, for muscle contraction and relaxation and nerve action potential. The body needs to keep these two minerals in balance because they work opposite of each other. Sodium and potassium have a relationship with blood pressure as well. If the content of sodium in the blood is high, this may affect water balance and may raise blood pressure. Sodium is mostly found in the form of sodium chloride (40% of salt is sodium, 60% is chloride) in food, that include salt, processed meats, canned soups and snack foods.
The source of potassium includes oranges, bananas, tomatoes, dried beans, milk and dried fruits. The sodium 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 function. Like sodium, potassium absorption is also very efficient in the body, but it mostly occurs in the small intestine. The kidneys regulate potassium balance and excessive potassium (hyperkalemia) may result from kidney damage or failure. The kidneys have regulated mechanism for reabsorbing sodium in the distal nephron and excretion of potassium ions. This mechanism is controlled by aldosterone, a steroid hormone produced by the adrenal cortex. Aldosterone promotes the excretion of potassium ions and the reabsorption of sodium ions. The release of Aldosterone is initiated by the kidneys. The re-absorption of sodium ions is followed by the reabsorption of water. This causes blood pressure as well as blood volume to increase. The present study is to compare the homeostasis of sodium & potassium in relation to variation in environmental parameter of the two totally different geographical clusters i.e. Aizawl (hill) and Varanasi (plain).

**Material & Methods**

A dietary survey questionnaire was prepared and distributed to 200 healthy individuals each from both sampling stations. The questionnaire was composed of demographic anthropometric, dietary and laboratory data. Each individual was interviewed together to get the relevant information as per questionnaire. The anthropometric measurement was taken for height, weight and blood pressure, and then accordingly body mass index was calculated. Random urinary and blood samples were collected to analyze the chief electrolyte components i.e. sodium and potassium.

The dietary data were collected by 24 hours using Dietary Recall Method. Dietary questionnaire describes the daily intake of food items in terms of quantity. Information on food habits, like and dislike, describe the daily intake (quantity) of carbohydrate, protein, fat, vegetable, fruits, snacks and beverages like tea, coffee and milk. The calculation of nutrient value of daily intake of diets as per chart provided by National Institute of Nutrition, Hyderabad and recommended by Indian Council of Medical Research, New Delhi for determination of intake quantity of electrolytes and nutrients. The dietary data collected through questionnaire was analyzed to calculate the nutrient and electrolyte intake. Nutrient intake includes carbohydrate, protein, fat, minerals, crude fiber and energy. Electrolyte intake includes sodium, potassium, calcium, chloride, iron and phosphorous. The body mass index (BMI) was calculated as weight in kilogram divided by the square of height in meters.

The analysis of urinary and serum electrolytes was carried out in auto-analyzer for sodium and potassium using ion selective electrode measurement. The electrode has an ion selective membrane that undergoes a specific reaction with the corresponding ions contained in the sample being analyzed. The membrane is an ion exchange, reacting to the electrical charge of the ion causing a change in the membrane potential, or measuring voltage, which is build up in the film between the sample and the membrane. A galvanic measuring chain within the electrode determines the difference between the two potential values on either side by the membrane. The galvanic chain is closed through the sample on one side by the reference electrode, reference...
electrode and the “Open terminal”. The membrane, inner electrode, inner electrode close the other site. A difference in ion concentrations between the inner electrolytes and the sample causes an electrochemical potential to from across the membrane of the active electrode. The potential is conducted by a highly conductive, inner electrode to an amplifier. The reference electrode is connected to ground as well as to the amplifier. The ion concentration in the sample is then measured points of standard solution with precisely known ion concentration.

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 considered statistically significant at p value <0.05.

Results

Gender ratio at both stations in the study represents high male 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).

**Table 1:** Anthropometric and Electrolyte parameters of study subjects in the two groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Aizawl</th>
<th>Varanasi</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>43.53 ± 9.41</td>
<td>44.22 ± 12.22</td>
<td>0.527</td>
</tr>
<tr>
<td>Height (in meter)</td>
<td>1.64 ± 0.09</td>
<td>1.66 ± 0.16</td>
<td>0.063</td>
</tr>
<tr>
<td>Weight (in kg)</td>
<td>58.02 ± 11.22</td>
<td>66.06 ± 11.68</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Body Mass Index (%)</td>
<td>21.70 ± 3.98</td>
<td>23.97 ± 3.69</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Systolic BP (in mmHg)</td>
<td>115.5 ± 13.58</td>
<td>131.06 ± 18.39</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diastolic BP (in mmHg)</td>
<td>71.52 ± 10.10</td>
<td>83.07 ± 13.51</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sodium intake (in gm)</td>
<td>183.50±106.03</td>
<td>326.47±18.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Potassium intake (in gm)</td>
<td>2589.59±1615.47</td>
<td>3475.19±1141.74</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Urinary Sodium (in meq/l)</td>
<td>131.07 ± 51.25</td>
<td>134.98 ± 68.85</td>
<td>0.520</td>
</tr>
<tr>
<td>Urinary Potassium (in meq/l)</td>
<td>32.20 ± 16.44</td>
<td>42.64 ± 30.44</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Serum Sodium (in meq/l)</td>
<td>137.92 ± 13.82</td>
<td>143.58 ± 26.26</td>
<td>0.007</td>
</tr>
<tr>
<td>Serum Potassium (in meq/l)</td>
<td>3.82 ± 0.91</td>
<td>4.19 ± 1.01</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Discussion

The result of above study revealed that, the altitude and variation in environment 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 due to increased intake energy and the variation in the work profile. Similar type of Indian study has been conducted on three groups of male soldiers at different climate conditions. The study results show significant difference in body fat content of three groups, which could be an adaptive feature to the environment. Another Wardha based Indian study on rural population shows strong correlation between BMI and waist circumference with systolic and diastolic blood pressure.
The systolic and diastolic blood pressure was measured to know the affect of BMI on individual health. The results of systolic blood pressure in Aizawl range observed was from 90 to 190 mmHg and in Varanasi, it was from 103 to 176 mmHg. The diastolic blood pressure of individual from Aizawl region range from 45 to 120 mmHg and in Varanasi region the value ranges from 60 to 110 mmHg. The reason of high blood pressure in Varanasi may be due to high BMI and increased extra salt intake. Similar study from turkey aimed to evaluate the blood pressure of children lived at three different altitudes shows that, a different 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. In 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. 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.

Daily sodium intake trough diet in Aizawl region is range from 10 to 568 gm and in Varanasi it was from 92 to 658 gm. The chief source of sodium is salt and processed meat. In Varanasi individual especially 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 sodium intake in individual from Varanasi as compare to individual from Aizawl. The dietary potassium intake was also observed high in Varanasi range from 1220 to 7466 gm in relation to Aizawl, that range from 103 to 8034 gm. Fruit and vegetable, which are the rich source of potassium that include leafy green vegetable, fruit from wines and root vegetable. In Varanasi especially in India, which we have selected for study is a city of lots of seasonal festival throughout the year. These festivals are celebrated by doing fasting with a fruit based diet, which is potassium 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 potassium intake in individual from Aizawl area. In a similar study from Zutphen, Netherlands shows a significantly inverse relationship between potassium intake and blood pressure.

The urinary sodium excretion was observed high in Varanasi individual (135 ± 68.85 meq/L) range from 23 to 316 meq/L as compare to Aizawl (131 ± 51.26meq/L) range from 27 to 316 meq/L. The reason high urinary sodium may be the increased Body mass index and. the variation in environmental condition such as temperature, humidity and rain fall. A study conducted in USA show no positive correlation between the dietary sodium and blood pressure in vegetarian and non-vegetarians. The individual from Varanasi have shown high urinary potassium excretion range from 2.8 to 140meq/L in relation to Aizawl ranging from 2.4 to 65 meq/L. The reasons of increased excretion may be the high potassium intake through diet. Similar type of study aimed to evaluate the effect of high altitude on urinary sodium potassium excretion found a temporary rise in excretion of sodium and potassium under exposure to 18000 feet of altitude. Similar type of study was conducted in China to examine the association of dietary sodium potassium intake on urinary sodium potassium excretion. The study result conclude that Western vegetarian diet of high sodium predispose the problem of hypertension.
The mean value of serum sodium level was observed high in Varanasi range from 96 to 310 meq/L, whereas in Aizawl individual it was range from 24 to 158 meq/L. The high serum sodium has reflected in the form of high blood pressure in subjects from Varanasi. The serum potassium level observed in Varanasi subject was high range from 2.6 to 7.9 meq/L in relation to Aizawl range from 1.4 to 8 meq/L. The reason of increased potassium level in serum may be due to the increased dietary potassium intake in Varanasi subjects. Similar study was conducted in three geographical locations i.e. Austria, Brazil and China that regional difference in potassium intake leads to differences in serum potassium value.

Conclusion

This study reveals that the body mass index and dietary sodium, potassium intake by plain subjects (Varanasi) was significantly higher than hill subjects (Aizawl). It has resulted in higher blood pressure and serum sodium, potassium in plain subjects as compare to hill subjects. The same pattern was observed in urinary sodium and potassium excretion at both sites. Therefore we can conclude that the population in hill region has a significant preventive role to reduce BMI and blood pressure in relation to population from plain region. In addition to diet physical activities also play very important role for regulation of BMI and blood pressure, which maintain the proportion of serum and urinary electrolyte. The people from plain region have higher blood pressure than hill due to different dietary habits, religious values and lesser workouts.

References