

Original Article

SALINITY IN DRINKING WATER AND BLOOD PRESSURE STATUS OF  
ADOLESCENT SCHOOL CHILDREN IN COASTAL AREA OF  
BANGLADESH

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ABSTRACT

**Background:** High dietary salt intake from food is a major risk factor for raised blood pressure (BP) worldwide. In the context of Bangladesh, information regarding salinity in water and blood pressure especially in the adolescent population is very scarce. This study was conducted to assess the blood pressure status of adolescent school children in coastal area of Bangladesh.

**Methods:** A one-year school based cross-sectional study was carried out among 528 students of class 8-10 at schools of Bajua Union, Dacope Upazilla, saline prone zone of Khulna district. Relevant data were collected by using pre tested semi-structured questionnaire with face to face interview & checklist. Blood pressure was measured in a controlled environment and Collected water sources were analyzed by DPHE, Water Testing Laboratory. The study was conducted in the schools of Bajua Union, Dacope Upazilla of the saline prone zone of Khulna district in between a one-year time frame.

**Results:** Among 528 participants most of them were male (353, 66.9%) with an age of 14 years (185, 35.0%). Most of them were read in class 8 (185, 35.0%). Prevalence of paternal, maternal, paternal grandparents' and maternal grandparents' history of hypertension were found significant. About 72.3% regularly took extra salt during meal and 43.9% took salt preserved fish with meal. Mean of systolic blood pressure of respondents were  $114.2197 \pm 7.61448$  mm of Hg. Mean of diastolic blood pressure of respondents were  $75.1780 \pm 5.45959$  mm of Hg. Mean of pulse pressure of respondents were  $39.0417 \pm 6.56430$ . Mean of mean arterial pressure of respondents were  $88.1919 \pm 5.44267$  mm of Hg. Sodium concentration of pond were approximately in between 500-600 mg/l, whereas in tube wells approximately in between 700-1100 mg/l.

**Conclusion:** Drinking water sodium is an important source of daily sodium intake, and therefore a risk factor for increased BP in salinity prone coastal areas. This adds to the cardiovascular health risks associated with food sodium intake in Southeast Asian populations. Low- saline alternative drinking water sources could effectively help to prevent high BP and hypertension-related morbidity and mortality in these coastal populations. New technologies for the supply of such alternative sources, including safeguarding the microbial quality, should be further studied.

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**Key Words:** Drinking water salinity, Blood pressure status, Adolescent school children, Coastal Bangladesh.

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INTRODUCTION

Salinity means the relative concentration of dissolved salts, usually sodium chloride, in given water<sup>1,2,3</sup>. NaCl accounts for almost 65.7% of the dissolved salts that causes salinity of water<sup>1-4</sup>. WHO experts defined 'salt' as a combination of sodium (Na) Potassium (K), Iron (Fe), Calcium (Ca), Magnesium (Mg), Chloride (Cl) and Sulphate (SO<sub>4</sub>)<sup>5-8</sup>. In 2002, the World Health Organization (WHO) recognized health impacts of consumption of highly saline waters as a priority for investigation under its public health initiatives<sup>8,9</sup>. Salinity intrusion into drinking water and its associated health impact is one such critical issue<sup>9-12</sup> with increased blood pressure (BP) or hypertension leading way to cardiovascular diseases (CVD)<sup>13,14</sup>. This is of particular concern for a country like Bangladesh where large coastal population drinks

water from sources with elevated salinity level<sup>15</sup>. Coastal areas of Bangladesh cover 20% of total land of the country<sup>16,17</sup>. Tidal and estuarine floodplains cover almost 98% of the coastal area<sup>18</sup>. Small areas (2%) with river floodplains and peat basins are found in the northern part of the coastal area<sup>19,20</sup>. Tidal floodplains occur in Satkhira, Khulna, Bagerhat, Pirozpur, Jhalukhati, Barisal, Patuakhali, Chittagong and Cox's Bazar district<sup>20,21</sup>. They cover a total of 18,65,000 ha or about 65% of the coastal area<sup>22,23</sup>. Estuarine floodplains occur in Noakhali, Bhola and Patuakhali districts and in the north-western part of Chittagong district<sup>24,25</sup>.

Hypertension (HTN) or high blood pressure, sometimes called arterial hypertension, is a chronic medical condition in which the arterial blood pressure is elevated<sup>25,26</sup>. High dietary salt intake from food is a major risk factor for raised blood pressure (BP) worldwide<sup>26-30</sup>. The prevalence of increased blood pressure is reported in 4 to 15% children worldwide, with increasing trends during recent decades<sup>31</sup>. In the present study, it was aimed to explore the relationship between salinity in drinking water and blood pressure status in school going adolescents living in coastal part of Bangladesh.

## METHODS

A one-year school based cross-sectional study was carried out among 528 students of class 8-10. For the

calculation of sample size mean and standard deviation (SD's) of blood pressure (systolic and diastolic) were used which values were taken from Robert W, T, EdwardJ, C (1981)<sup>32</sup>. Schools of Bajua Union, Dacope Upazilla of the saline prone zone of Khulna district which was established by baseline survey data of national drinking water quality of Bangladesh<sup>33,34</sup>. Data was collected by conducting face to face interview with questionnaire on school children after having their informed consent. The questionnaire was included socio demographic characteristics information, sources of drinking and cooking water, extra salt intake and salted fish intake, family history of blood pressure related information. Blood pressure was measured in a controlled environment after five minutes of rest in the sitting position on the right arm supported at heart level and was taken for three times<sup>35-37</sup>. Collected water sources were analyzed by DPHE, Water Testing Laboratory.

## RESULTS

Among 528 participants most of them were male (353, 66.9%) with mean age of 14 years (185, 35.0%). Most of them were from class 8 (185, 35.0%). Baseline characteristics for 528 participants shown in **Table 1**.

Prevalence of paternal, maternal, paternal grandparents' and maternal grandparents' history of hypertension are enlisted in **table 01**. About 72.3% regularly took extra salt during meal and 43.9% took salt preserved fish with meal (**Table 01**).

**Table 1: Socio-demographic characteristics of respondents**

Traits	Coastal area (%)
<b>Gender</b>	
Male	66.9
Female	33.1
<b>Age</b>	
14	35.0
15	34.5
16	30.5
<b>Religion</b>	
Muslim	27.8
Hindu	68.9
Christian	3.2
<b>Level of education</b>	
Class 8	35.0
Class 9	35.5

Class 10	30.5
<b>Familial history of hypertension</b>	
Family history	82.0
Father	32.4
Mother	30.3
Paternal Grandfather	14.0
Paternal Grandmother	13.6
Maternal Grandfather	10.0
Maternal Grandmother	15.5
<b>Behaviour Characteristics</b>	
Consumption of extra table salt with meal	72.3
Consumption of extra salt from food	83.1
Consumption of salt preserved fish	43.9
<b>Source of drinking water</b>	
Deep tube well	21.5
Pond	61.0
Rain water	17.8
<b>Source of cooking water</b>	
Deep tube well	19.3
Pond	75.6
Rain water	5.1

Mean of systolic blood pressure of respondents were  $114.2197 \pm 7.61448$  mm of Hg. Mean of diastolic blood pressure of respondents were  $75.1780 \pm 5.45959$  mm of Hg. Mean of pulse pressure of respondents were  $39.0417 \pm 6.56430$ . Mean of mean arterial pressure of respondents were  $88.1919 \pm 5.44267$  mm of Hg (**Table 02**). Means of four types of blood pressure were calculated after adjustment for the effect of age, family history of high blood pressure, extra salt and salted fish intake.

The sodium measurements showed high sodium concentrations in several drinking water sources including some of the tube well sources, however, with large variation within each type of source (**Table 3**). Sodium concentrations of pond were approximately in between 500-600 mg/l, whereas in tube wells approximately in between 700-1100 mg/l (**Table 3**).

**Table 2: Blood pressure of the respondents (mean  $\pm$ SD)**

Blood Pressure	Coastal area (%)
SBP	$114.2197 \pm 7.61448$
DBP	$75.1780 \pm 5.45959$
PP	$39.0417 \pm 6.56430$
MAP	$88.1919 \pm 5.44267$

**SBP**= Systolic Blood Pressure, **DBP**= Diastolic Blood Pressure, **PP**=Pulse Pressure, **MAP**= Mean Arterial Pressure

**Table 3: Distribution of the respondents according to Na Level by Water Source**

District	Upazila	Mouza	School Name	Water Source Type	Na (mg/l)
Khulna	Dacope	Bajua 19 No.	Bajua High School	Pond	500
		Bajua 19 No.	West Bajua High School	Pond	600
		Chunkuri*	Nil	Shallow Tube Well	1100
		Chunkuri**	Chunkuri High School	Shallow Tube Well	700

## DISCUSSION

Regarding sodium concentration, the current study revealed that sodium concentration in ponds, tube wells systems are extremely high and found a significant association between sodium level in drinking water and blood pressure. The results are similar with previous study related to dietary sodium reduction, though the effect of sodium found in water is somewhat higher than has been reported for food containing sodium<sup>27,37-39</sup>. This might be partly explained by the way imbibed sodium is absorbed in the body compared to sodium consumed through food<sup>40</sup>. Other studies<sup>41,42</sup> have found reversibility of blood pressure changes through manipulation of sodium in drinking water and found similar results.

This study was a cross-sectional study conducted on adolescent to assess their blood pressure status and sodium level of drinking water. Although in several other studies on sodium level in drinking water were carried out in the last 3 decades of the 20th century - mainly analyzing the salinizing effect of certain water softeners<sup>25,43-45</sup>. The high drinking water sodium concentrations described here are of particular importance, as they affect millions of people living in poor coastal areas, in which often no or very limited alternative sources are available for consumption.

This study was done in coastal area of Bangladesh, findings may be more widely generalizable to other deltaic areas in South-East Asia<sup>46,47</sup>. An increase of 1.9 g of dietary salt per day is associated with a 32% increase of stroke risk<sup>48-50</sup>. A systematic review indicated that reduction of dietary sodium intake below 2 g/d would lead to a fall in systolic/diastolic blood pressure of 3.47/1.81 mmHg, associated with a 19% reduction in stroke risk, a 39% decrease in stroke mortality and a 42% decrease in coronary heart disease mortality<sup>26</sup>. This study found a strong effect on blood pressure for sodium consumed through water than through food, this may translate into a larger sodium-related morbidity and mortality in coastal areas of Bangladesh.

## CONCLUSION

Sodium in drinking water is an important source of daily sodium intake and therefore it is a risk factor for increased BP in salinity prone coastal areas. This adds to the cardiovascular health risks associated with sodium intake in foodstuff in Southeast Asian populations. Water sources with low salinity could effectively help to prevent high BP and hypertension-related morbidity and mortality in coastal populations. New technologies and advancement for the supply of such alternative sources, ensuring the microbial quality, should be further studied.

## ETHICAL APPROVAL

The objectives and importance of the research were explained to all participants prior to recruitment. Participation in the study was voluntary. The confidentiality of the participants was maintained, and written informed consent was obtained from all. The study was approved by the Institutional Review Board (IRB) of the National Institute of Preventive and Social Medicine (NIPSOM) and obtained an ethical clearance waiver from same source.

## DECLARATION

No funding facilities were available for this study and all authors have read and approved the final version of the manuscript and also none of the participating authors has a conflicting financial or other interest related to the work detailed in this manuscript.

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