Exploring the impact of soil and water salinity on dietary behavior and health risk of coastal communities in Bangladesh
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ABSTRACT
The purpose of this study was to evaluate the impact of soil and water salinity on dietary behavior and health risk in the coastal people of Bangladesh. This study was conducted among 240 respondents in rural coastal sub-districts in Khulna and Patuakhali of Bangladesh using a simple random sampling technique. To evaluate the association between health risk and salinity exposure categories, a multinomial logit regression analysis was conducted and statistical significance was declared at $p < 0.05$. A significantly higher amount of salinity (NaCl) level was found in radish, potato, bean, bitter gourd, rice, shallow tube-well, and pond water from Patuakhali than Khulna. Males and those aged 36–50 years (RRR: 1.89, SE: 0.58) and 51–65 years (RRR: 4.51, SE: 1.81) were associated with hypertension compared with the females (RRR: 0.57, SE: 0.18) and age group 20–35 years. Consumption of shallow tube-well water (RRR: 3.12, SE: 1.46), salt content rice (RRR: 1.36, SE: 0.50), salt content vegetables (RRR: 1.09, SE: 0.09), salt content fish (RRR: 2.77, SE: 0.47), and intake of table salt (RRR: 1.05, SE: 0.03) were significantly associated with risk factors of hypertension ($p < 0.01$).

A sustainable policy for salt reduction through dietary interventions along with the promotion of low saline foods and drinking water must be a priority with special emphasis on coastal areas.

Key words | coastal area, dietary behavior, hypertension, relative risk ratio (RRR), salinity, salt consumption

HIGHLIGHTS
- Increasing salinity has become a vital issue for the people living in the coastal regions of Bangladesh.
- Saline water and food sources contribute highly to overall salt consumption in coastal regions.
- Males and adult persons had a significantly higher probability of hypertension than females.
- Consumption of saline water and salt content food was significantly associated with hypertension.
- Safe water options having low saline content alone or together with dietary and lifestyle interventions need to be investigated.

INTRODUCTION
Sea level rise (SLR) is considered as one of the major reasons for salinity intrusion into soil and groundwater...
which results from both natural and human-induced climate change (Wassmann et al. 2004; Sarwar 2005). Due to its geographical position (low lying belt), Bangladesh experiences frequent effects of climate change. People living in coastal areas of Bangladesh are struggling with the adverse impacts of climate change (Talukder et al. 2016). In recent years, as a result of sea-level rise, soil and water salinity is increasing and at the same time, frequent storms and cyclones are occurring (BBS 2011a, 2011b; IPCC 2014). Increasing salinity has become a vital issue for the people living in the coastal regions of Bangladesh (Rabbani et al. 2017). An increasing amount of salinity in the water and soil of these regions causes scarcity of drinking water, problems in irrigation, agriculture, and severe diseases like hypertension and kidney disease (CEGIS 2006; Khan et al. 2011a; Mahmuduzzaman et al. 2014). Several studies suggested that inhabitants of those areas have a high salt intake level as they largely depend more on rivers, groundwater sources, and ponds for drinking water (Khan et al. 2011a, 2011b; Rasheed et al. 2014) than those living more inland and this intake may increase their risk of hypertension and other diseases (Rahman & Ravenscroft 2003; Rasheed et al. 2014). In coastal areas of Bangladesh, both surface water and groundwater are contaminated by varying levels of salinity and these have the potential to affect the health of 35 million inhabitants living in these regions through direct or indirect use of water resources (Khan et al. 2011b). The population is vulnerable to climate change and sea-level rise in low-lying settings and commonly use untreated water and food sources and are likely to have similar exposure to high sodium consumption (Nicholls et al. 2007; Vineis et al. 2011). According to the World Health Organization, a significant percentage of the population in the coastal region are exposed to a higher level of sodium than the recommended daily intake (>5 g/day) (Khan et al. 2011a, 2011b; Rasheed et al. 2014). Several studies of food consumption have found a relationship between dietary sodium and an increase in blood pressure (BP) (Aburto et al. 2013; He et al. 2015). Approximately one-third of the total deaths in the world and three-quarters of deaths in both low- and middle-income countries are caused by cardiovascular disease (CVD) (World Health Organization 2015). Also, in 2010, CVD was one of the major causes of deaths in Bangladesh (El-Saharty et al. 2013).

In coastal areas of low lying countries like Bangladesh, food is considered as the major source of sodium which causes high blood pressure (Habiba et al. 2014; Talukder et al. 2017) and at the same time in those regions, water salinity (sodium) has been found to be associated with higher sodium consumption (Khan et al. 2014; Talukder et al. 2017). In particular, in the southwestern areas of Bangladesh, high salinity in surface and groundwater sources is affecting human health. SRTT (2011) found that severe diseases like kidney stones and rheumatism can be caused by high saline contaminated drinking water. Rasheed et al. (2014) claimed that coastal families have money to spend, but there are not enough fresh fruit or vegetables in the market to spend it on. The local communities are forced to survive on locally available food varieties.

Although there have been many studies on the salinity levels of soil and water and its associated effect on crop production and adaptation strategy, and on the land fertility in coastal areas of Bangladesh (Ali 2006; IPCC 2007; Khan et al. 2011b), research on the health impact and food behavior of the coastal communities in the southern part of Bangladesh are hard to find, despite its massive significance due to climate change and increasing soil salinity in the coastal region in South Asia, particularly in Bangladesh. The health impact is gradually increasing in the coastal communities of Bangladesh. Considering these research gaps, the main purpose of this study was to evaluate the impact of soil and water salinity on dietary behavior and the health risk of local coastal communities in Bangladesh.

MATERIALS AND METHODS

Study design, setting, and population

A cross-sectional survey was conducted in three remote subdistricts, Dacope and Paikgacha of Khulna, and Kalapara of Patuakhali, in the southwestern coastal area of Bangladesh between December 2016 and May 2017. Soil and water salinity are the major constraints of agricultural productivity. The problem is particularly acute in the area where soil salinity is relatively high (Figure 1). Furthermore, most of the vegetable crops are very sensitive to saline conditions and each unit increase in salinity with yield decreased from
6–19% (SDRI 2010; Das et al. 2019). Cropping intensity is reduced considerably due to high soil and water salinity. These sub-districts are also prone to salinity intrusion as it is part of the exposed coastal classification (PDO-ICZMP 2003; SDRI 2010). In short, we selected three unions (Dacope Sadar, Paigacha Sadar, and Kalapara Sadar), based on the diversity of foods and potable water uses. In this study, four villages were randomly selected from each union using a simple random sampling technique. Trained research staff made household visits for data collection from the selected villages and, of those, 240 participants were available for interview and health assessments.

**Questionnaire regarding dietary measurements**

The daily dietary intake and the previous 7 days diet of the respondents was assessed by a 24-hour recall method and Food Frequency Questionnaire (FFQ) method including the consumption of the principal component of each food item from each of the eligible participants collected during household visits. To obtain dietary consumption, we adopted the food frequency questionnaire used in the Bangladesh Integrated Household Survey. The questionnaire included 12 food items. These questionnaires were designed to assess the habitual diet by asking about the frequency with which food items or specific food groups were consumed over a reference period of the previous week (Burk & Pao 1976; Chen et al. 2004; Ahmed et al. 2013). Moreover, the amount of water a person drinks per day was collected through a questionnaire survey, and salinity was measured by testing the samples from that specific source. The amount of raw salt (table salt-NaCl) consumed by the respondent during the meal was also collected through a questionnaire survey.

**Water and food sample analysis**

Water samples were collected manually based on standard protocols and field practices. We collected drinking water samples from different sources: open ponds, shallow and deep tube-wells. For analysis purposes, only the results of tube-well water were used as this is the major source of drinking water, and a cutoff point of 150 meters was established to differentiate between a shallow and a deep
tube-well (BBS 2011a, 2011b). Five types of food items, such as rice, potato, bean, bitter gourd, and radish (2 kg each sample), were collected from local markets of the selected regions. The food items were processed within 2–3 hours after purchasing. The vegetables and rice samples were cleaned and oven-dried at 80 °C for 1 week. The dried samples were pulverized by using an electrical blender and passed through the 20 μ mesh sieve to make a fine powder. Fifty grams of each sample was packed in a polybag and sealed for further analysis. Three replicates of each sample were randomly used for salinity analysis. Samples from participants’ drinking water and food sources were measured for salinity in parts per thousand (ppt) using a conductivity meter (Model: Sension5, company: HACH, origin: USA) at the internationally accredited laboratory at Asia Arsenic Network (AAN), Jashore, Bangladesh (Al Nahian et al. 2015). Salinity measures are reported in Electrical Conductivity (EC) in milligrams per liter (mg/L) and grams per liter (g/1,000 g) for drinking water and food sample analysis where 1 ppt = 1,000 mg/L.

Covariates

Information on socio-demographic conditions, the sources of drinking and cooking water, years of using the water sources, health status, and diet of the past 7 days including consumption of rice, vegetables, fish, and table salt intake of each participant were collected. Using a graphical representation of these methods, the data were described by compiling it into graphs and tables.

Empirical analysis

The potential uncertainty and bias of univariate analysis have emphasized the need for multinomial logit model analysis which considers the effects of all risk factors influencing disease in coastal areas. In contrast with gender, age category, region, drinking water source, cooking water source, bathing water source, amount of salt intake from rice consumption, amount of vegetable intake, amount of table salt intake and amount of water intake data are in a discrete format. The database used in the current study has five discrete severity of disease categories: disease-free, hypertension, kidney disease, skin disease, and other diseases. The disease classification is based on only the individual disease. An ordered probability model may be most convenient in this study. Following the common use of unordered discrete outcome models, a multinomial logit model for health impact levels was used to explain the severity of health impact (salt intake from saline foods in coastal people) on dietary behavior among the five categories of disease. This model permits the use of a categorical dependent variable (Theil 1969).

In the general case of a random effect context of the health impact outcomes, the probability of disease by consuming salinity containing foods and water of a coastal community can be specified as:

\[ Y_{ki} = \alpha_k + \beta_k X_{ki} + \epsilon_{ki} \] (1)

where \( Y_{ki} \) is an outcome variable such as the different types of disease \( k (k = 1, \ldots, 5) \) of sample \( i (i = 1,\ldots, n) \), where \( n \) is the total number of observations, \( \alpha_k \) is a constant parameter for health impact outcome category \( k \); \( \beta_k \) is a vector of the estimable parameters of each category; \( X_{ki} \) represents a list of explanatory variables which are responsible for determining health impact outcomes and \( \epsilon_{ki} \) is a random error term that is independently and identically distributed. As the samples are categorized into different disease types, therefore, we assume the error term (\( \epsilon_{ki} \)) is following the generalized extreme value (i.e. Gumbel) distribution, where the probability of falling disease types \( k \) of sample \( i \), conditioning on the explanatory variables \( X_{ki} \) and a constant \( \alpha_k \). Hence, the multinomial logit model forms as follows:

\[ P_k = \Pr[Y_i = k] = \frac{\exp(\alpha_k + \beta_k X_{ki})}{\sum_k \exp(\alpha_k + \beta_k X_{ki})} \] (2)

In our empirical framework, the estimated coefficients were used to evaluate the probabilities of the disease falling into one of the five categories. Our model consists of five probabilities, \( P_k (k = 1, \ldots, 5) \), related to the five categories of disease (i.e. disease-free, hypertension, kidney disease, skin disease, and other diseases). The probability of being no disease, hypertension, kidney, skin disease, and other diseases are denoted as \( P_1 \), \( P_2 \), \( P_3 \), \( P_4 \), and \( P_5 \) respectively. As a
result, the sample likelihood of the multinomial logit model (Equation (2)) follows the standard maximum likelihood method. Since the explanatory variables are continuous and discrete determining factors, log-odd ratios of the outcomes become:

\[
\ln \left( \frac{Pr(Y_i = k - 1)}{Pr(Y_i = k)} \right) = \beta_i X_k - \beta_n X_k = (\beta_i - \beta_n)X_k
\]  

(3)

Thus, the coefficients are distinguishable only up to an additive constant so only the difference in coefficients is identifiable. One outcome (the base category) of the coefficient is fixed to zero to resolve this interdeterminacy. Due to the non-linear characteristics of the multinomial logit model, the estimated coefficients of the independent variables do not represent their effects on the dependent variable. In that manner, the relative risk ratio (RRR) represents the effect of a relevant risk factor. In our analysis, the RRR of risk factors is computed relative to the base category (i.e. no disease). For instance, the relative probability of health impact outcome \((k = 2)\) to the base category \((k = 1)\) is given as:

\[
Pr(k = 2) / Pr(k = 1) = \exp (x_p^{(k-2)})
\]  

(4)

Therefore, the RRR is written as:

\[
RRR = \exp (x_p^{(k-2)})
\]  

(5)

Equations (4) and (5) imply the RRR of hypertension \((k = 2)\) relative to the disease-free \((k = 1)\) category. Similarly, if we consider \(k = 3, 4, 5\) it will indicate the RRR of kidney, skin, and other diseases relative to disease-free \((k = 1)\) types. Moreover, the intuition of RRR of an independent variable indicates the increase \((RRR > 1)\) or decrease \((RRR < 1)\). In this study, the multinomial logit model and the associated RRR were estimated using Stata (version 13.0). All dietary patterns were entered into the same model. The model was adjusted for potential confounding by gender, age, region, source of drinking water, source of the cooking water, and source of bathing water, which influenced the risk of health status and is also associated with the dietary pattern scores. Statistical tests were two-sided, and \(p < 0.05\) was considered a statistically significant level.

Ethics statement

The research method was approved by the Institutional Review Board (IRB) of the Human Research Ethics Committee at Jashore University of Science and Technology, Bangladesh. All the study participants were formally consented before their participation and signed consent was obtained for each participant.

RESULTS

Sociodemographic status

A total of 54.16% of the survey respondents were male and 45.84% were female (Table 1). About 36% were 20–35 years old, 40% were 36–50 years old, 19.17% were 51–65 years old and 5% were > 65 years old. Among them, 36.25% of the respondents were farmers and 13.75% of the respondents were housewives.

### Table 1: Characteristics of the respondents participated in this study

| Occupation                  | Khulna (%) | Patuakhali (%) | Total (%) | \(p\)-value |
|-----------------------------|------------|----------------|-----------|-------------|
| Gender                      |            |                |           |             |
| Male                        | 47.55      | 58.31          | 54.16     | 0.001       |
| Female                      | 53.45      | 41.69          | 45.84     |             |
| Age category                |            |                |           |             |
| 20–35 years                 | 30.0       | 41.67          | 35.83     |             |
| 36–50 years                 | 45.0       | 35.0           | 40.0      | 0.03        |
| 51–65 years                 | 22.5       | 15.83          | 19.17     |             |
| > 65 years                  | 2.50       | 7.50           | 5.0       |             |
| Occupation                  |            |                |           |             |
| Farmer                      | 44.17      | 28.33          | 36.25     |             |
| Housewife                   | 10.83      | 16.66          | 13.75     | 0.02        |
| Farmer + Fisherman          | 25.0       | 32.50          | 28.75     |             |
| Farmer + Businessman        | 20.0       | 22.50          | 21.25     |             |
Salt content test in some local food items grown in the coastal region

Figure 2 explains the salinity level of food samples which were collected from coastal areas. The salinity level of different food samples was significantly higher in Patuakhali and Khulna relative to the standard level. Among the selected food samples of Patuakhali district, a high amount of salinity level (NaCl) was found in radish (12.4 g), potato (8.2 g), bean (5.9 g), bitter gourd (6.5 g), and rice (2.1 g) per 100 g sample. In Khulna district, a slight difference in salinity level was found in both Dacope and Paikgacha upazilla.

Water salinity (NaCl) levels

Location-wise variations in salinity (NaCl) levels of drinking water are shown in Figure 3. The highest proportion of respondents exposed to more than 600 mg/L sodium chloride were found in both Patuakhali and Khulna. Excess salinity (NaCl) levels were detected in pond water of Kalpara (940 mg/L), Paikgacha (760 mg/L), and Dacope (876 mg/L). However, in both Patuakhali and Khulna, water salinity was found to be slightly lower in deep tube-wells than the upper limit of the Bangladesh standard (600 mg/L) (Akter et al. 2016).

Impact of salinity on dietary behavior and health risk

The estimated severity of the disease model is presented in Table 2. The RRR estimates explain the differences compared to the disease-free, whereas the base variable of the corresponding model is disease-free (Ye & Lord 2014). The model fitted with the data fairly well inclusive with a large chi-square statistic ($\chi^2 = 119.2$) and a very small $p$-value (0.000) for the goodness-of-fit (Table 2). The choice of a multinomial logit model instead of an ordered logit is justified because the significant risk factors are fairly different for hypertension, kidney disease, skin disease and other diseases (Rifaat et al. 2011). The outcome of the estimated model is interpreted using the RRR. The estimated results indicate that the risk of hypertension severity level was expected to decrease nearly 0.6 times (RRR: 0.57, SE: 0.18) in females relative to the disease-free respondents (Table 2). The relative risk of hypertension, kidney disease, skin disease and other diseases in Khulna region was expected to decrease by 0.04 (RRR:0.04, SE:0.02), 0.02 (RRR:0.02, SE:0.01), 0.11 (RRR:0.11, SE:0.04) and 0.13 (RRR:0.13, SE:0.03) times respectively relative to disease-free respondents in Patuakhali. The severity level for hypertension and skin disease was expected to increase by 1.9 and 1.2 times in 36–50-year-old people relative to 20–35-year-olds, but the probability of kidney disease was decreased
0.3 times in 36–50-year-olds compared to 20–35-year-old people. For 36–50-year-olds, the estimated severity levels of hypertension and kidney disease were increased by 4.5 and 3.2 times relative to 20–35-year-olds. The severity of skin disease and kidney disease significantly increased by about six (RRR: 5.84, SE: 0.00) and 1.2 times (RRR: 1.21, SE: 0.05) in >65-year-olds relative to the 20–35-year-olds. Conversely, the risk of hypertension was expected to decrease 1.0 times (RRR: 0.92, SE: 0.50) in those >65 years than 20–35-year-old people (Table 2).

For shallow tube-well water relative to deep tube-well water, the relative risk for hypertension, kidney disease, and skin disease relative to disease-free respondents would be expected to significantly increase by a factor of 3.1 (RRR:3.12, SE:1.46), 3.0 (RRR:2.98, SE:1.28), and 4.8 (RRR: 4.79, SE: 2.04) times respectively. The relative risk ratio explains that if a respondent increased salt content rice, vegetables, and fish intake score by one unit/one serving, the risk of hypertension relative to the disease-free respondents would be expected to increase by 1.4 (RRR:1.36, SE:0.50) and 1.1 (RRR:1.09, SE:0.09), and 2.8 (RRR:2.77, SE:0.47) times respectively whereas the other variables in the model are constant (p < 0.01). The probability of hypertension and kidney disease were expected to increase by 1.3 (RRR:1.26, SE:0.81) and 5.5 (RRR:5.43, SE: 2.34) times than disease-free respondents who used shallow tube-well water for cooking rather than pond water (Table 2).

Figure 4(a) and 4(b) describes the predicted marginal effect of hypertension and kidney disease in terms of age and gender of people who consume salt-containing foods and water in coastal areas. These plots compared the probability of hypertension of people who were in different age groups and gender. The vertical axis of these plots shows the possibility of hypertension, the horizontal axis shows the age category and the colored curve shows the different gender of the respondents. The figure shows that males had a higher risk of hypertension than females, and it also shows that both gender and age were important factors for increasing the risk of hypertension (Figure 4(a)). It is
indicated that the 36–50 year age range had moderate risk and those aged 51–65 years had a higher risk of hypertension. Above this, it also explains that males (51–65 years and 36–50 years old) had more risk than females. Figure 4(b) shows that females had a higher risk of kidney disease than males and both gender and age were significant factors to increase the risk of kidney disease. The age 36–50 year age range had a lower risk than those aged 20–35 years.

Figure 5(a) and 5(b) shows the predictive marginal effect of skin disease and other diseases with age and gender with a 5% level of significance. Figure 5(a) shows that males have
a comparatively higher risk of skin diseases than females. It also explains that both age and gender were important factors for increasing the risk of skin disease. Figure 5(b) shows the varying probabilities of other diseases (diarrhea, fever, gastric, etc.) in both males and females and at the same time indicates that not only age but also gender was another influencing factor for an increase or decrease in these diseases.

Figure 6 shows the type of diseases suffered. Most of the respondents in both Patuakhali (43%) and Khulna (36.67%) district had hypertension and the rate of hypertension was higher in Patuakhali than Khulna. Lastly, the results show that the percentage of hypertension, kidney disease, and skin disease was higher in Patuakhali than in Khulna district.

Frequency distributions for the type of suffered disease by different age groups are given in Figure 7. In this study, respondents in the age range 20–35 years (31.4%), 36–50 years (44.79%), 51–65 years (43.48%) and >65 years (41.67%) suffered from hypertension but the percentage was higher in the 36–50 years age group.

**DISCUSSION**

This study revealed that the consumption of high salt containing foods and potable water was positively associated with hypertension, kidney disease, and skin disease in the studied population aged above 20 years in the rural coastal
area of Bangladesh. Notably, the outcomes of this study pointed out that the severity risk level of hypertension was lower in females than males and the males had a significantly higher salt intake than females (Brown et al. 2009; Ortega et al. 2011). The severity level for hypertension, skin disease, and kidney disease was increased by 2.0, 1.2, and 1.4 times respectively in 36–50-year-olds relative to 20–35-year-olds but the probability of kidney disease was expected to decrease 0.3 times in 36–50-year-olds compared to 20–35 year-olds. Our findings were consistent with previous studies...
(Hassan & Shah 2006; Khan et al. 2008; Rasheed et al. 2014; NIPORT 2015). The results of the current study show that the salinity level was found to be significantly higher in coastal areas in drinking water sources, so there was a possibility to increase the prevalence of several diseases. The coastal people of this study used sodium contaminated ground and pond water for drinking purposes which may increase the risk of hypertension. Similar findings have been shown in other studies conducted in Bangladesh (Rahman & Ravenscroft 2003; Khan et al. 2011a; Rasheed et al. 2014). Some researchers also revealed that drinking high saline (~1.6 g) drinking water was related to higher salt intake than recommended (Khan et al. 2011a; Talukder et al. 2016).

The results of this study showed that intake of salt-containing rice, vegetables, fish, and table salt was associated with hypertension. Respondents who increased their consumption score by one serving relative to disease-free respondents would be expected to increase by 1.4, 1.1, 2.77, and 1.05 times while other variables in the model are held constant ($p < 0.01$). The probability of kidney disease was expected to increase nearly 1.8, 1.02, 1.86, and 1.1 times relative to disease-free respondents who increase the consumption of salt-containing rice, vegetables, fish, and table salt by one unit/one serving. According to Heck et al. (2010)) and Islam (2013), the dietary pattern is likely to contribute $\sim$500–700 mg of daily sodium intake. It is now known that various cardiovascular and other diseases are related to excess salt consumption (Ezekowitz et al. 2003; Flack et al. 2003; He & MacGregor 2009; Strazzullo et al. 2009). Consumption of high sodium causes left ventricular hypertrophy-like fibrosis in the heart, kidney, and arteries (Safar et al. 2000; Frohlich 2007; Varagic et al. 2008). From several studies, it has been found that saline water sources contribute highly to overall salt consumption in coastal regions of Bangladesh despite the food being considered as the major source of salt in the human body (Talukder et al. 2016, 2017). In consideration of the fact that the World Health Organization suggested the recommended dietary salt intake is 5 g/day (WHO 2013), the level of salt intake in Bangladesh is not low so it is better to avoid additional salt consumption by extra table salt intake and locally grown food. Because of inadequate nutritional knowledge, most of the people in the study area did not realize that high salt consumption is detrimental. Nevertheless, a limited number of people knew that excess salt consumption is associated with hypertension and kidney disease which indicates that limited nutritional knowledge has reached the community.

From the collected data in this study, it appears that most of the respondents agreed that hypertension was a common disease in their community. Among the total respondents, nearly 77% had a disease and only 23% were disease-free. In this study, most of the people suffered from hypertension and the rest of them suffered from kidney disease, skin disease, and other diseases such as fever, gastric problems, and diarrhea respectively. Since most of the people in the research area were ignorant about the natural occurrence of salt in both coastal foods and water, it is therefore essential to make people aware about the salt content in their food. In Bangladesh, due to a lack of national data on salt intake from regular food sources, and with the current geographic variations in salt intake, it is important to understand the different sources of dietary salt when designing appropriate strategies for different communities. Considering the harmful health consequences of high salt intake, special attention should be given to coastal areas that are prone to saline intrusion in food and water sources and areas where cheap raw salt is easily available (Rasheed et al. 2001; Khan et al. 2008). It is important to formulate policies and specific programs in the coastal areas focusing on reducing the population’s standard level of salt intake, besides organizing different campaigns to raise consumer consciousness between salt intake and health problems (Neale et al. 1993; Marshall et al. 2007). The direct health impacts of increased environmental salinity have yet to be addressed adequately.

**CONCLUSIONS**

In summary, salinity levels of different food and water samples were significantly higher in Patuakhali and Khulna. This research indicates that the increased risk of hypertension, kidney, and skin disease among the coastal population in Bangladesh was due to the high salinity concentration in daily food intake, drinking, and cooking water sources. Males and those aged 36–50 and 51–65...
years had a significantly higher probability of hypertension and skin disease compared to females. From this research work, it has been shown that most of the people in the concerned study consumed more than 5 g of salt daily compared to their biological needs and this was significantly associated with hypertension. In the interim, safe water options having low saline content alone or together with dietary and lifestyle interventions need to be investigated. So, at the community level, certain strategies should be developed to reduce salt intake and at the same time awareness should be created about the effect of excessive salt intake on health.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

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First received 19 June 2020; accepted in revised form 24 September 2020. Available online 9 November 2020.