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Effect of saline water on the health status of pregnant women in Barguna district of coastal Bangladesh: A climate change study

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ABSTRACT

Drinking water from natural sources in coastal Bangladesh has become contaminated by varying degrees of salinity due to saltwater intrusion from rising sea levels, cyclone and storm surges, and upstream withdrawal of freshwater which exerts detrimental effects on the health condition of coastal people. Pregnancy itself is a crucial time for women when the salinity increases its vulnerability regarding the raising of blood pressure. A study on the effect of saline water intake on the health status of pregnant women was undertaken in different saline prone areas of Taltoli upazilla of Barguna district of coastal Bangladesh to observe the effect of salinity on the systolic and diastolic blood pressure. The salinity was measured as the sodium (Na) concentration in urine by biochemical analysis and subsequent blood pressure was taken in the local private diagnostic laboratory. It was revealed that the average age, Na concentration, water intake, urine output, systolic and diastolic pressure were 20.00, 167.5, 3.13, 1.13, 100 and 70 for 1st trimester and 23.53, 169.76, 3.44, 1.13, 110 and 72.35 for 2nd trimester and 25.50, 168.83, 3.63, 1.15, 113.33 and 74.58 for 3rd trimester respectively. In case of parity average age, Na concentration, water intake, urine output, systolic and diastolic pressure were 21.36, 160.50, 3.46, 1.14, 106.34 and 72.14 for 1st parity and 24.27, 170.33, 3.43, 1.11, 110 and 72 for 2nd parity and, 24.27, 170.33, 3.43, 1.11, 110 and 72 for 3rd parity respectively. Correlation matrix express that sodium concentration has the significant association with the age and the highly significant association with systolic and diastolic blood pressure. Logistic regression model was fitted to observe the effects of sodium with systolic and diastolic blood pressure (bp) separately. The odds ratio (OR) estimate shows that women with systolic bp ≥120 had 1.109 times greater sodium concentration than with systolic blood pressure of <120 and, with diastolic bp ≥ 80 contain 1.064 times greater sodium concentration than with diastolic blood pressure of < 80.

Introduction

Climate change attributed to flood, drought, and salinity intrusion in water, cyclone etc. which have direct and indirect adverse impacts on health condition of human. Recently, scarcity of world's freshwater resources, one of the critical impacts carrying situations on health, has been becoming a concern. In coastal Bangladesh, natural drinking water sources, such as rivers and groundwater, are threatened by saltwater intrusion from the Bay of Bengal. According to the intergovernmental panel on climate change (IPCC), groundwater, crop soils, and many rivers are likely to become increasingly saline from higher tidal waves and storm surges, as a result of climate change impacts (Parry et al., 2007). About 20 million people, living along the coast of Bangladesh, relies heavily on rivers, tube wells (groundwater), and ponds for washing, bathing, and obtaining drinking water, affected by varying degrees of salinity in drinking water (MOEF, 2006). Domestic ponds, take up 10% of the total land area, are primarily rain fed but can also mix with saline water from rivers, soil runoff, and shallow groundwater (Rahman & Ravenscroft, 2003). Sodium helps keep the water and electrolyte balance and can measure by a test for 24-hour test or a one-time (spot) test to checks how much sodium is in the urine. But its high dietary intake has some detrimental effects of health specially causes high blood pressure (Chobanian, 2000). Pregnancy is a very critical time for women where any deviation from normal physiology can be more harmful than normal health. Normally, diastolic and systolic blood pressure tend to fall during mid-pregnancy and then return to normal by week 36 (Thomburg et al., 2000) and the normal sodium level of pregnant women become lower at 132-140 mmol/L of blood and 40-220 mmol/day of urine (Tran, 2005). Any increase in sodium level can cause the high blood pressure on pregnant women along with other outcomes. As the people of the study area depends mainly on the saline water for regular family use, there may be the increase the chances of rising sodium level in urine and subsequent raising of blood pressure which may affect the health of the people. For the above facts, the study was undertaken to observe the sodium concentration of urine of pregnant women in the study area and to determine the correlation of sodium concentration with other variables of age, parity, trimester, water intake, urine output and systolic and diastolic blood pressure.

Materials and methods

Sampling

Barguna district is one of the saline prone areas in Bangladesh. The study was conducted in Taltoli upazilla of Barguna district. Taltoli is divided into seven administrative unions that comprise 84 villages, with a

total population of 150,500 people. For this study we select 33 number pregnant women randomly in various area between age 16 and 35 years. Selection is done on the basis of trimester such as 1st, 2nd & 3rd trimester and on the basis of parity we select 1st, 2nd & 3rd parity.

The water intake with the source and urine output/day was calculated and single sample was collected from each woman after taking data about the parity and time of the gestation period. The blood pressure was measured and the urine was analyzed for sodium concentration.

For a 24-hour urine collection, all of the urine that pass over a 24-hour time period were collected. A clean and dry container was used to collect the sample during the collection at home. The sample was collected at day 1 and 2 from 1st urination of the days (after wake up in the morning). Urinary Sodium concentration analysis was done at Comfort Diagnostic Lab by electrolyte analyzer machine (EasyLyte Analyzer Machine, made by Germany).

Data analysis

A logistic regression model was fitted univariately and least significant value < 0.05 were considered as candidates for the multiple logistic regression model (Hosmer & Lemeshow, 2000). In this study the dependent variables are systolic blood pressure which categorized as ≥ 120 and < 120 and diastolic blood pressure categorized as ≥ 80 and < 80.

Results and Discussion

The frequency of pregnant women distributed to different villages in the study area where 18% women comes from Vaijora, followed by 15% from each of Behala, Tatipara and Satonpara and 6% from Joyalvanga, Sohanpara and Amkhola and equal 3% Taltoli and Gendamara (Fig. 1).

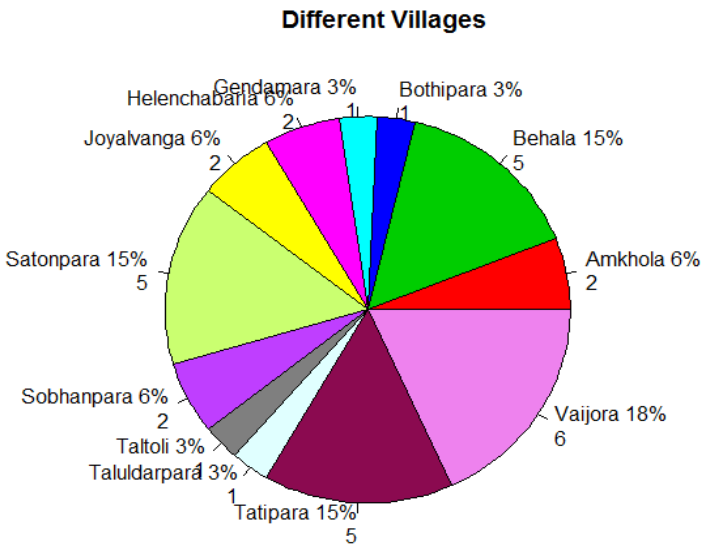

Fig. 1. Frequency of pregnant women at different villages in the study area.

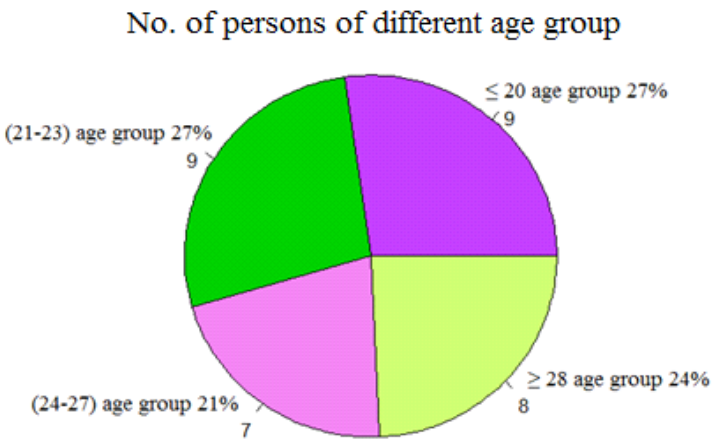

Fig. 2. Number of persons of different age group.

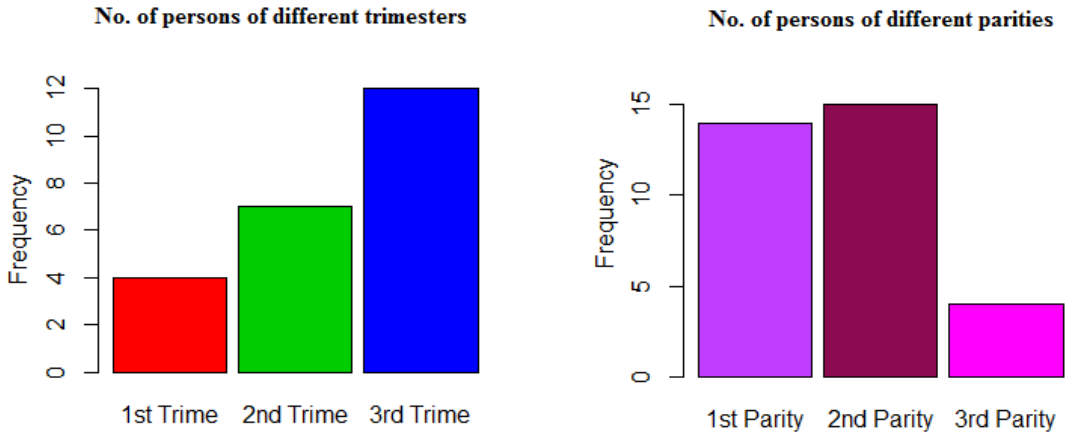

Fig. 3. No. of persons of different trimesters and parities.

Table 1 demonstrated the descriptive statistics of different trimester where the average age, Na concentration, water intake, urine output, systolic and diastolic pressure were 20.00, 167.5, 3.13, 1.13, 100 and 70 for first trimester and 23.53 169.76,3.44,1.13,110 and 72.35 for 2nd trimester and, 25.50, 168.83,3.63, 1.15,113.33 and 74.58 for 3rd trimester, respectively (Fig. 2 & 3) Table 2 demonstrate the descriptive statistics of different parity where the average age, Na concentration, water intake, urine output, systolic and diastolic pressure were 21.36, 160.50, 3.46, 1.14, 106.34 and 72.14 for 1st parity and 24.27, 170.33,3.43,1.11,110 and 72 for 2nd parity and, 24.27, 170.33,3.43, 1.11,110 and 72 for 3rd parity respectively. It was found that the correlation among the different variables where sodium concentration has the significant association with the age and the highly significant association with systolic and diastolic blood pressure (Table 3, Fig. 4).

Table 1. Descriptive statistics of different parameters across trimesters.

Trimester	No. of persons	Parameters	Mean	Standard Deviation	Minimum	Maximum
1st	4	Age	20.00	4.08	16	24
		Na concentration	167.5	6.45	160	175
		Water intake	3.13	0.75	2.25	3.75
		Urine output	1.13	0.25	0.75	1.25
		Systolic BP	100	8.16	90	110
		Diastolic BP	70	8.16	60	80
2nd	17	Age	23.53	4.46	18	34
		Na concentration	169.76	28.70	110	240
		Water intake	3.44	0.70	2.50	4.75
		Urine output	1.13	0.16	0.75	1.25
		Systolic BP	110	10.60	90	130
		Diastolic BP	72.35	8.31	60	90
3rd	12	Age	25.50	4.60	20	35
		Na concentration	168.83	26.73	140	230
		Water intake	3.63	0.79	2.25	4.75
		Urine output	1.15	0.17	0.75	1.25
		Systolic BP	113.33	8.88	100	130
		Diastolic BP	74.58	7.82	70	95

Table 2. Descriptive statistics of different parameters across parity.

Parity	No. of persons	Parameters	Mean	Standard Deviation	Minimum	Maximum
1st	14	Age	21.36	3.63	16	30
		Na concentration	160.50	15.97	140	190
		Water intake	3.46	0.66	2.25	4.75
		Urine output	1.14	0.15	0.75	1.25
		Systolic BP	106.43	7.45	100	120
		Diastolic BP	72.14	6.99	60	80
2nd	15	Age	24.27	3.95	20	34
		Na concentration	170.33	29.32	110	240
		Water intake	3.43	0.82	2.25	4.75
		Urine output	1.11	0.19	0.75	1.25
		Systolic BP	110	11.34	90	130
		Diastolic BP	72	7.75	60	90
3rd	4	Age	24.27	3.95	20	34
		Na concentration	170.33	29.32	110	240
		Water intake	3.43	0.82	2.25	4.75
		Urine output	1.11	0.19	0.75	1.25
		Systolic BP	110	11.34	90	130
		Diastolic BP	72.00	7.75	60	90

Table 3. Correlation matrix among the different variables.

	Sodium conc.	Age	Water intake	Urine output	Systolic bp	Diastolic bp
Sodium conc.	1					
Age	0.41801**	1				
Water intake	-0.07715	-0.02909	1			
Urine output	0.09536	0.12363	0.61883***	1		
Systolic bp	0.72697***	0.5725***	0.13432	0.27324	1	
Diastolic bp	0.69631***	0.42067**	0.06187	0.22385	0.79514***	1

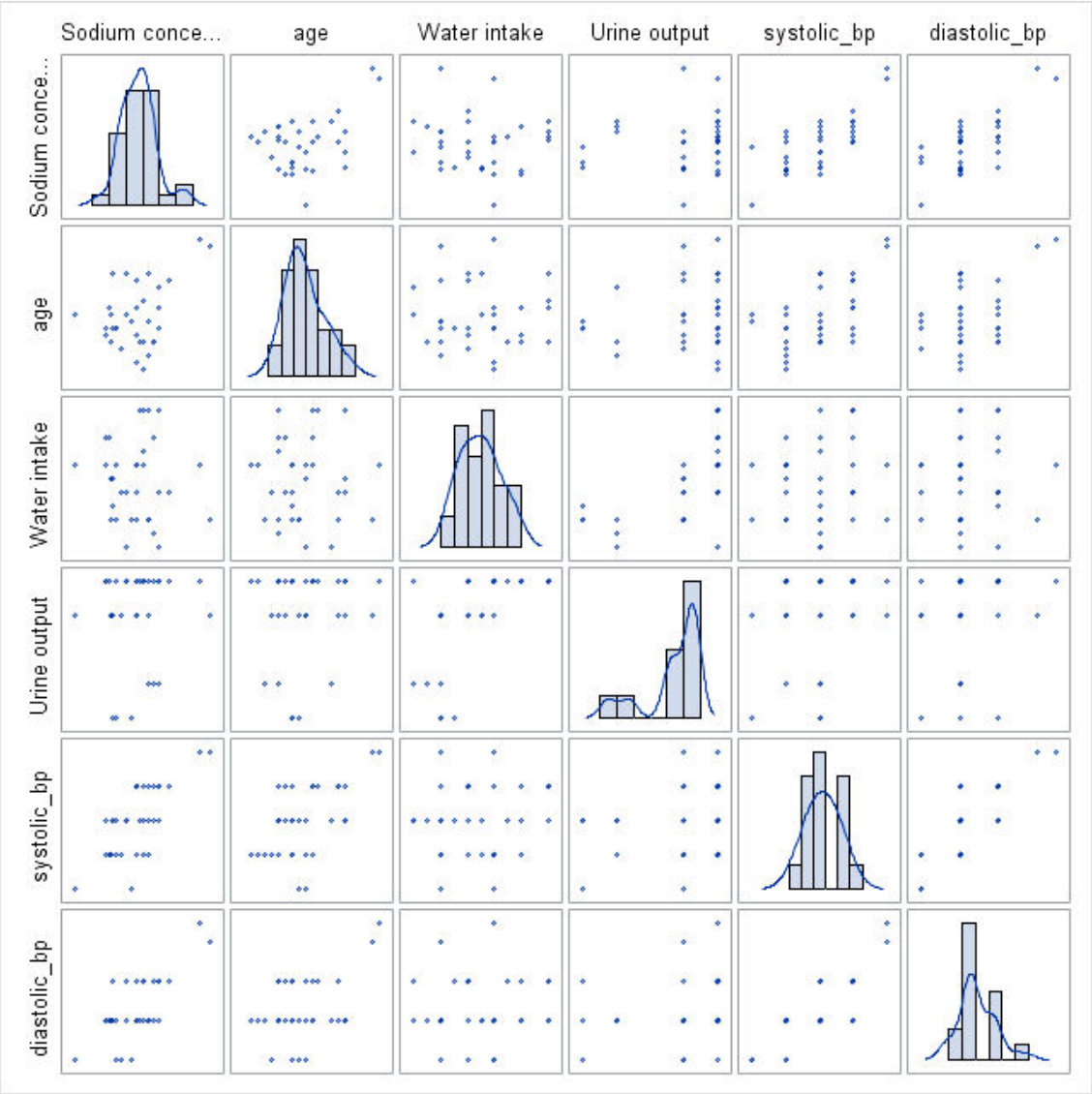

Fig. 4. Scatter diagram of different variables.

Logistic Regression Model

Logistic regression model was fitted for systolic and diastolic blood pressure (bp) separately. All parameters were > 0.05 level of significance except sodium concentration for both models. Hosmer & Lemeshow goodness of fit test was done, chi-square=4.87; p-value=0.68, for systolic bp and chi-square=5.28; p-value=0.63 evidence carried out that the model fit best. The small p value (<0.0001 and 0.0017) for the likelihood ratio (LR) chi-squared statistic implies that sodium concentration effect in the model is important for predicting the probability of systolic and diastolic bp.

The p-value for sodium concentration effect is smaller than .05 for both model indicating that 95% CI for OR excludes 1. The parameter estimate of sodium concentration was concluded that the log odds of systolic bp of ≥120 increases, as sodium concentration increases 0.1033 units (Table 4). The odds ratio (OR) estimation showed that the odds of systolic bp ≥120 for the sodium concentration was exp (0.1033) = 1.109 times greater than the systolic blood pressure of <120.

The parameter estimate of sodium concentration was concluded that the log odd of diastolic blood pressure of ≥ 80 increases, as sodium concentration increases

0.0617 unit (Table 5). The odds ratio (OR) estimate shows that the odds of diastolic bp ≥ 80 for the sodium concentration was exp (0.0617) = 1.064 times greater than the diastolic blood pressure of < 80.

The study express that the average sodium concentration is higher (169.76 mmol/day) than 1st (167.5 mmol/day) and 3rd (168.83 mmol/day) trimester. In case of parity the average Na^+ concentration is higher in 3rd parity (195.00 mmol/day) than 1st (160.5 mmol/day) and 2nd (170.33 mmol/day) parity. In case of age, average Na^+ concentration is higher (235 mmol/day) at the age between 31 and 35 years than the age between 16 and 30 years. The normal sodium level of pregnant women becomes lower at 132-140 mmol/L of blood (Tran, 2005). In this study the parameter was found higher as the people of the study area depends mainly on the saline water for regular family use, there may be the increase the chances rising of sodium in urine and subsequent raising of blood pressure which may affect the health of mother and future child. In a survey conducted in 2008, higher rates of (pre) eclampsia and gestational hypertension in pregnant women living in the southwestern coast of Bangladesh, compared with noncoastal pregnant women, were hypothesized to be caused by saline contamination of drinking water (Khan et al., 2008). This study denotes that urinary sodium concentration has the significant association with the age and the highly significant association with systolic and diastolic blood pressure. Similar study of dietary intake of salt with high sodium has some detrimental effects of health where evidence proves that high sodium intake is causally related to high blood pressure (Chobanian, 2000) and some observational studies and clinical trials performed in general populations provide overwhelming evidence that higher salt intake is associated with raised blood pressure (Alderman, 2000; He & MacGregor 2007; Law et al., 1991; Midgley et al., 1996).

Table 4. Parameter estimates and Standard errors (in parentheses) for systolic blood pressure.

Parameter	Estimate	Pr > ChiSq	Odds ratio (OR)	95% C.I. for OR
Intercept	-18.607 (7.2199)	0.01	-	-
Sodium concentration	0.1033(0.041)	0.0117	1.109	1.023, 1.202

Table 5. Parameter estimates and Standard errors (in parentheses) for diastolic blood pressure.

Parameter	Estimate	Pr > ChiSq	Odds ratio (OR)	95% C.I. for OR
Intercept	-11.3311(4.5952)	0.0137	-	-
Sodium concentration	0.0617(0.0263)	0.0190	1.064	1.010, 1.120

Conclusion

The estimated salt intake from drinking water in this population exceeded recommended limits. The problem of saline intrusion into drinking water has multiple causes and is likely to be exacerbated by climate change-induced sea-level rise. The presence of high levels of salt in drinking water sources in rural coastal Bangladesh is a cause of public health concern and a challenge for the government of Bangladesh. We hypothesize that increasing salt intake during might contribute to the hypertension in pregnancy in coastal Bangladesh, and the problem may be exacerbated by future sea-level rise and environmental change in association with other fetal outcomes. Although, this study had some pit fall of short duration, minimum samples, unequal sample size from different age groups, parities and trimesters, but the result of this study will certainly help the future public health workers to take steps to overcome the situation of adverse effect of salinity in the coastal area of Bangladesh.

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