Contribution of saline drinking water to high salt consumption in young adults in coastal Bangladesh

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Presenter Disclosures

Mohammad Radwanur Rahman Talukder

The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

“No relationships to disclose”
Introduction

- Saltwater intrusion is an emerging environmental problem in low-lying countries including in Bangladesh (Mimura, 2013).
- In coastal areas of Bangladesh livelihoods and health of more than 35 million people are currently affected, which is projected to aggravate further (Dasgupta, 2014).
- Ample and well accepted evidence on adverse health effects of high salt consumption, particularly from food→ little information about exposure from increased water salinity (Vineis, 2011).
- This research examined the salt exposure and potential health risks of increasing salinity in potable water in coastal areas of Bangladesh in order to promote relevant intervention strategies.
Introduction and Background
Methods
Results
Implications and Conclusions
Coastal Areas of Bangladesh

- 19 districts
- 32 percent of the total land area
- ~35 million population

(PDO-ICZMP 2003)
Coastal Areas (contd)

- Areas of multiple vulnerabilities (Minar, 2013)
- Low-lying- 86% of the land have an elevation up to 5 meter (Nishat & Mukherjee 2013)
- 12 districts (half of the coastal total land area)- cyclone risk, salinity intrusion and tidal water movement (Dasgupta, 2014)
Water Supply and Salinity

- Direct water use from natural surface (e.g. pond, river) and groundwater sources (e.g. tubewell).
- Affected by varying level of salinity (Khan et al., 2011)
- Saltwater is moving further inland (BADC, 2011, SRDI, 2012)
Salinity Concentration in Groundwater

Groundwater level went below the mean sea level
Groundwater salinity level was ~10,000mg/L
Soil Salinity Bangladesh

- Salinity level is increasing and more areas are being affected by higher salinity (SRDI, 2012)
Salt Exposure and Health Effects in Bangladesh

- Limited data available (Vineis et al., 2011)
- Among pregnant mothers -
  - High salt consumption
  - Pre-eclampsia (Khan et al. 2011, 2014)
- Adult (aged 25 years and above)
  - Coastal vs High vs Plain land- High salt consumption (Rasheed et al. 2014)
Methods
Study settings

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- Two unions
  - Amadi-pond
  - Koyra Sadar-TW (BBS, 2011)

- Four villages
Study Population

Listing of eligible household members aged 19-25 years - 418 subjects

Available during interview - 340 subjects

Excluded
Pregnant cases - 21
Refusal/ incomplete interviews - 4

Successful interview - 315 subjects

Urinary data available - 282 subjects
Data Collection

- May-June 2014

- Questionnaire interview
  Dietary history- Food, water

- Biological marker- Spot urine samples

- Environmental monitoring- water salinity assessment

- Questionnaires- Source, duration

- Internal exposure measurement

- Total exposure estimate
Findings
### Characteristics of the Respondents

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>N</th>
<th>%/ Mean (sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>184</td>
<td>65.9</td>
</tr>
<tr>
<td><strong>Education (years)</strong></td>
<td>275</td>
<td>7.7 (2.8) (mean)</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical labour</td>
<td>107</td>
<td>38.3</td>
</tr>
<tr>
<td>Housewife</td>
<td>101</td>
<td>36.2</td>
</tr>
<tr>
<td>Non labour</td>
<td>71</td>
<td>25.5</td>
</tr>
<tr>
<td><strong>Wealth index (n=239)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>80</td>
<td>33.4</td>
</tr>
<tr>
<td>Middle</td>
<td>83</td>
<td>34.7</td>
</tr>
<tr>
<td>High</td>
<td>76</td>
<td>31.8</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>279</td>
<td>21.2 (4.1) (mean)</td>
</tr>
</tbody>
</table>
Water Sources and Salinity Level

Mean- 884 mg/L (95%CI 820, 949)
Mean- 738 mg/L (95%CI 620, 856)

Bangladesh standard- 200mg/L
US EPA- 30-60mg/L
## Urinary Sodium - Spot and Estimated 24-hour Level

<table>
<thead>
<tr>
<th>N=279</th>
<th>Urinary sodium (UNa) mmol/L</th>
<th>Kawasaki* Estimated 24-hour urinary sodium (mmol/d)</th>
<th>Tanaka* Estimated 24-hour urinary sodium (mmol/d)</th>
<th>INTERSALT* Estimated 24-hour urinary sodium (mmol/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean+ sd</td>
<td>103.7 (70.5)</td>
<td>197.4 (61.0)</td>
<td>137.1 (34.8)</td>
<td>118.6 (27.3)</td>
</tr>
<tr>
<td>Median (IQR^)</td>
<td>91.5 (43.3, 154.8)</td>
<td>192.1 (157.6, 233.8)</td>
<td>134.4 (114.7, 156.4)</td>
<td>115.4 (99.9, 133.9)</td>
</tr>
<tr>
<td>Range</td>
<td>10.5, 298.0</td>
<td>62.3, 469.6</td>
<td>59.7, 248.3</td>
<td>41.9, 203.6</td>
</tr>
<tr>
<td>Abnormal (%) (&gt;100 mmol/d)</td>
<td>-</td>
<td>95.3</td>
<td>88.1</td>
<td>74.9</td>
</tr>
</tbody>
</table>

* formula described in Cogswell et al., 2013
# Association between drinking water sources and 24 hour urinary sodium

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>95%CI</th>
<th>p for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude (n=279)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface water/Pond</td>
<td>Ref 9.7</td>
<td>3.1, 16.3</td>
<td>0.004</td>
</tr>
<tr>
<td>Tube well water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted (n=254)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface water/Pond</td>
<td>Ref 13.8</td>
<td>7.8, 19.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tube well water</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Adjusted for sex, education, occupation, socio-economic status, BMI, added salt
Implications
Dietary salt and health risks

• Direct link $\rightarrow$ Hypertension (WHO, 2012; He, 2009)
  $\rightarrow$ Cardiovascular and Kidney diseases
  (Koliaki, 2013)

• Increase of SBP$\rightarrow$ 1.8-4.3mmHg; increase of DBP$\rightarrow$
  $\sim$0.0-1.2mmHg (INTERSALT study)
Projected Climate Change and Salinity

• Climate change will cause significant changes in river salinity in the southwest coastal area of Bangladesh (Dasgupta, 2014)

• The freshwater river area (0–1 g/L) is anticipated to decline from 40.8 percent in 2012 (March) to <20 percent for 2050 (Dasgupta, 2014)

• An increase of moderate to highly saline river areas (3 to above 5 g/L) from the baseline in 2012
Food vs Water Contribution

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Food vs Water Contribution

- Fruits
- Rice
- Potato
- Vegetables
- Fish
- Water

Sodium content (mg/kg)

Islam et al., 2013
Heck et al., 2010
This research

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Conclusions

- Drinking water contributes to high sodium consumption in young population → increasing risk of hypertension
- Climate-induced sea level rise is likely to exacerbate already excessive salinity levels
- We need specific health prevention interventions and adaptation strategies
  - Short-medium term - reduction in salt through diet
  - Medium-long term - alternative safe water options
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