

# **Steven Goldsmith, PhD** Villanova University

**Speaker** 

Sodium and Drinking Water





## Sodium and Drinking Water



#### Steven T. Goldsmith, PhD Department of Geography and the Environment, Villanova University



### Increasing Concentrations in Streamwater



#### Average annual sodium concentrations from Schuylkill River in Philadelphia, PA



Interlandi and Crockett (2003)

 Sodium and chloride concentrations are increasing in watersheds with historic road salt application\*

\*Kaushal et al. (2005); Interlandi and Crockett (2003); Kelly et al. (2005); Daily et al. 2014; Kaushal et al 2018



### Water Sodium Ingestion and Hypertension

- Coastal Bangladesh vulnerable to saltwater intrusion due to increasing sea level
- Elevated salinity in drinking water associated with higher BP in young coastal populations
- Median sodium concentration was:
  - Rain water: 31 mg/L
  - Pond water: 208 mg/L
  - Tube well water: 704 mg/L





## USEPA Guidelines for Sodium in Drinking Water

- Sodium is not formerly regulated by the USEPA as a primary or secondary contaminant in drinking water
- USEPA recommended guidelines
  - Should not 30–60 mg/L to avoid adverse effects on taste
  - Should not exceed 20 mg/L for individuals restricted to a total sodium intake of 500 mg/day (US EPA, 2003)





## Sampling Design

- Weekly tap water samples collected from three homes (Nov 2018- March 2019)
  - Pottstown
  - East Falls
  - Havertown
- Samples collected on same day & time
- Each residence serviced by different municipal agency





### Sample Analysis

- All samples analyzed for sodium and chloride concentrations using a Dionex 1100 ICS unit
- Standards, replicates, and independent check stds employed



<u>Disclaimer</u>: Sodium in drinking water is combination of river water chemistry and water treatment chemicals



### Link between Road Salt Runoff and Sodium Spikes in Drinking Water

### Winter 2018-2019

- Late season spike in sodium concentrations observe for all 3 locations
- Coincides with peak snow melt period
- All samples exceeded 20 mg/L





Cruz et al. (2022); GeoHealth



### Link with River Chemistry

#### East Falls Residence

Link between:

 CI- concentration in weekly tap water

&

 5-day average conductivity values for the Schuylkill River<sup>1</sup>



<sup>1</sup>USGS Guaging Station 01474500 (Schuylkill River @ Philadelphia, PA)



### Differences By Location

 Significant differences observed in sodium concentrations by location





### Relationship with Hypertension

- % contribution to recommend dietary guidelines
- Normal vs. low salt diet



#### Table 3

Percent Contribution of Water Ingested Sodium Toward Recommended Sodium Ingestion Guidelines

	Tolerable up	per limit (TUL) <sup>a</sup>	Low sodium <sup>b</sup>			
	Women (%)	Men (%)	Women (%)	Men (%)		
Philadelphia						
Average	6.1	8.3	10.1	13.9		
High range	13.7	18.8	22.9	31.3		
Havertown						
Average	4.0	5.5	6.7	9.2		
High range	8.2	11.3	13.7	18.8		
Pottstown						
Average	2.5	3.4	4.2	5.7		
High range	3.5	4.8	5.8	7.9		

<sup>a</sup>U.S. Institute of Medicine's tolerable upper limit (TUL) of 2,500 mg day<sup>-1</sup> (Institute of Medicine, 2005). <sup>b</sup>U.S. National Institute of Health-National Heart blood and Lung Institute's Dietary Approaches to Stop Hypertension diet recommendation of no more than 1.5 g per day for populations at risk of hypertension (NIH, 2006).

Cruz et al. (2022); GeoHealth



### Not a one-year Phenomenon!

- Long-term analysis of Philadelphia Water Department data
- Annual reported Sodium concentrations vs. annual snowfall





Cruz et al. (2022); GeoHealth



### **Municipal Records Review**

Part II: Review of Annual Water Quality Reports for 40 municipalities in snow affected regions (min. pop 40,000)

- 1. Reporting of sodium concentrations
- 2. Language on risks of sodium ingestion is provided
- 3. Recommended values provided for individuals
- 4. Acknowledge road salt as a potential contaminant



### Tap Water Sodium Risk in other Municipalities

					L	anguage _	Ac	knowledge roa	d			
						on risks Re	ecommended	salt as poten	tial			
					# Of	of sodium	value(s)	contamina	nt (Y/N) <sup>e</sup>			
		Average			sai	nples ingesti	on provided	l for				
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		concentration				nroyided nro	widedsalt re	estircitye				
Source	City, sta	te (mg/L)	Range $(mg/L)$ Dr	inking water sourc	e Year of record	$(Y/N)^{b}$	$(Y/N)^{c}$	liets $(Y/N)^d$	Indirect	Direct		
	May	where we y										
New Jersey	Američáh Water (2021)	Elizábéth, NJ	- 18-1	01 C Surtace wa	ater'and	^2020 · ·	ΝΥΥ	`` N	**	N	N	**
· Ne	wark Water and Sewer (	2019) Ne <sup>i</sup> warki, NJ	~~ 23.2*	– ^ Su	rtace water	2012018	ν N	`` N ``	Ν	Ϋ́Υ	*7	Y
	Suez (2021)	Jersey C	ity, –	36–60	Surface water	2020	) N	Y	Y		Y	ľ
Y	Passaic V	alley Water	Paterson, NJ	- 46.1-9	04.8 Surface w	vater	2020	Ν	Y	Y		Y
			New York									
Y	Y City o	f Albany Department of T and Water Supply (2	Albany, NY	20.3	20.0–270	Surface water	2	2020	Ν	Y	Y	
	Y Y	Buffalo Water (2		falo, NY 1	1 –	Surface	water	2020-2021	N	Y Y		Y
Y	Y Y	New Y <mark>o</mark> rk City I <del>En</del> vironmen	epartment of al Protection (2021)	New York City, NY	12	9–44 Surfa	ace water	2020	0 Y (	(n = 300)	Y	

- 25% of the cities provide a "detected value"
- Only 55% of cities provide a range of values



Language on risks of sodium ingestion is provided (43% of cities)

• Recommended values provided for individuals (38% of cities)

"Water containing more than 20 ppm of sodium should not be used for drinking by people on diets that severely restrict sodium. Water containing more than 70 ppm of sodium should not be used by people on diets that moderately restrict sodium." (City of Albany Department of Water & Water Supply, 2021).



- Acknowledge road salt as a potential contaminant
  - 1) Indirectly (UEPA Boiler plate language; 88% of cities)

"Inorganic contaminants, such as <u>salts</u> and metals, which can be naturally occurring or result from urban storm water runoff, industrial or domestic wastewater discharge, oil and gas production, mining or farming" (US EPA, 2021).





### Effective Communication of Environmental Driver?

• Acknowledge road salt as a potential contaminant

#### 2) Directly (48% of cities)

PARAMETER	NYSDOH MCL (Highest Level Allowed)	EPA MCLG (Ideal Goal)	# SAMPLES	RANGE	AVERAGE	MCL VIOLATION	LIKELY SOURCES IN DRINKING WATER
Sodium (mg/L)	NDL (10)		308	9 - 54	17	No	Naturally occurring; road salt; water softeners; animal waste

Source: New York City Department of Environmental Conservation



### What Can We Do to Reduce Our Exposure Risk?

- Point of use (POU) water pitcher filters
- POU filters selected based on their availability in most retail stores and their relatively low price point



Brita<sup>™</sup> standard filter





Zerowater™

Pur<sup>™</sup> Basic



Effective of POU Water Pitcher Filters for Reducing Sodium Exposure Risk

- Analyzed efficacy of POU filters over their advertised lifespan
- Used Na solution of 20 mg (more results forthcoming)





### Conclusions

- Snow melting events in road salt affected regions can lead to substantial spikes in tap water sodium concentrations
- 2) Study results likely an underestimate of Na ingestion risk
- 3) Need for real-time communication of Na ingestion risk
- Certain POU filters (e.g. ZeroWater<sup>™</sup>) can substantially reduce sodium exposure risk

