

Public Response to Elevated Levels of Arsenic in Drinking Water: An Investigation of Survey Participation, Risk Perception and Averting Behavior

Kati Ireland Stoddard^{*}, W. Douglass
Shaw^{*}, Mary Riddel⁺, Paul Jakus[#], Mark
Walker^{**}, and Laura Schauer^{##}

^{*} Texas A&M University, ⁺ University of
Nevada, Las Vegas, [#] Utah State
University, ^{**} University of Nevada,
Reno, and ^{##} PA Consulting.

Introduction and Background

- In 2001 EPA updated the standard for Arsenic (As) in drinking water from 50 ppb to 10 ppb
- As is a colorless, tasteless, semi-metal found naturally in rocks, air, soil, plants, animals, and water
- Can also occur due to technological, industrial, or commercial activities
- Municipal and private water demands deplete water levels in aquifers which causes As to release from the rock through oxidation

(USEPA (United States Environmental Protection Agency), 2006)

Introduction and Background

Continued

- 40 public water systems out of compliance with the new As standard
- 35 of the 40 are small water systems serving less than 3,300 people
- 72,000 on people public systems
- Private water systems not regulated or monitored
- No guarantee all mortality risks eliminated at 10ppb

(USEPA (United States Environmental Protection Agency), 2005)

Health Risks of Arsenic

- Lung and bladder cancer
- Exact dose-mortality relationship uncertain
- Personal risk factors: age, smoking history, period of exposure, frequency of ingesting contaminated water
- Other diseases: ischemic heart disease, diabetes, hypertension, skin cancer, and possibly prostate cancer, nephritis, nephrosis, hypertensive heart disease, and non malignant respiratory disease.

(Pinsker, L.M., 2001, Scientific Advisory Board, E.P.A., 2001)

Objectives

- Investigate factors influencing the decision to participate and the decision to engage in averting behaviors of treating tap water and buying bottled water.
- Investigate role of risk perception in averting behavior of treating tap water and buying bottled water
- Explore the influential factors of these decisions using a model

Hypotheses

1. Respondents living in households with children are more likely to treat than household with no children
2. Respondents with high perceived risks associated with arsenic are more likely to treat their tap water than those with low risk perceptions
3. Respondents with higher incomes (greater than \$45,000) are more likely to purchase bottled water than those with lower incomes

Hypotheses Continued

- Also investigated the influence of key variables on the decision to participate in the survey and the decision to treat tap water:
 1. Age is positively correlated to the decision to participate
 2. Income is positively correlated with the decision to treat tap water

Project Design

- Subproject of a larger EPA funded project investigating risk perceptions, averting behaviors, and willingness to pay for improved drinking water quality
- Included focus groups, pre-test survey, and full scale survey
- Full Scale Survey
 - 748 completed screener calls
 - 353 completed follow-up calls

Sample Methodology

- Project focus was on areas with naturally occurring As levels exceeding 10ppb
- 3 Locations chosen with public system out of compliance:
 - Albuquerque, NM
 - Fernley, NV
 - Oklahoma City, OK
- One location chosen because of high levels in private wells:
 - Appleton, WI

Survey Methodology

- Phone-mail-phone format
 - Screener call
 - Agree to participate and receive brochure
 - Final follow-up call
- Screener call used to recruit eligible participants
 - Data collected on:
 - Respondents' source of drinking water
 - Their level of concern for a variety of social and environmental issues
 - Demographic variables

Survey Methodology Continued

- Respondents sent information brochure which included general information on:
 - Arsenic and associated health risks
 - Treatment options
- Also included survey questions related to their:
 - Health and health history
 - Willingness to pay for reductions of arsenic in their tap water
- Asked to mark risk ladders to represent their risk perception

Survey Methodology Continued

- Final follow-up phone call
 - 10 days following screener call
 - Surveyors obtained answers to questions posed in the brochure and respondents' risk ladder marks

Data Analysis

- Summary statistics consisting of means, medians, frequencies, minimums, and maximums determined for both pretest and full scale survey data
- Frequencies illuminated degree of diversity or stratification in sample
- In general summary statistics revealed basic characteristics of entire sample and important percentages within sample

Data Analysis: Modeling

- Logit model used to analyze the influence of various variables in respondents' decision to participate and decisions to engage in averting behavior
- Later we estimated a simple model of treatment expenditures to analyze the influence of various variables in respondents' decision to treat their tap water

Results

- Interesting information revealed through summary statistics of the follow-up data set

Water Consumption and Behavior	Frequency	Percent
Tap Sole Source of Drinking Water	231	65.4%
Tap Sole Source for Cooking and Beverage Making	302	85.6%
Treat Water in the Home	182	51.60%
Member of the Household Drinks Bottled Water	117	33.1%

Type of Water System	Frequency	Percent
Public Water System	242	68.56%
Private Water System	111	31.44%

Children in Households Surveyed	Frequency	Percent
Number of the 353 Household Surveyed with Children	136	38.2%
Total Number of Children in HHS surveyed	628	

Results of Subjective Risk Models

Subjective Risk Models (Risk Ladder 1- own and range of risks*)				
Variable	Model I Coefficient	Model I Z	Model II Coefficient	Model II Z
Constant	0.0102	2.31	0.0017	0.36
Ownhealth (1 excellent, to 5 poor)	-----		0.0022	4.20
Education	-0.00046	-1.85	-0.0002	-0.93
Ownrent	-0.0054	-2.62	-0.0047	-2.35
Type of water system (0 = private, 1 =public)	0.0024	2.11	0.0023	2.09
Smoker	0.0028	2.72	0.0024	2.41
Arsenic concern rating (1, not important, to 5 very important)	0.001	2.97	0.001	3.15
Goodness of Fit	L=323.556		L=323.09	
	L.R.x ² =37.63		L.R.x ² =54.7	
Number of Observations	270		270	

Results of Subjective Risk Models Continued

- Higher education levels and homeownership had a significant effect on lowering risk perception (Model I)
- Smokers and those with lower self-health status ratings had higher risk perceptions (Model II)
- Respondents more concerned about arsenic levels in the drinking water indicated higher risk perceptions
- People on public systems expressed higher risk perceptions than those on private systems

Results: Simple Model of Treatment Expenditures

- Statistically significant factors:
 - Mortality Risk Perception (+)
 - Homeownership(+)
 - Believe treating tap water is too expensive (-)
 - Rating of drinking water safety (1 to 5, with 5 being the most safe) (-)

Variable	Coefficient	P > t
RISK	3918.09	0.011
OWNRENT	65.3277	0.116
TOOEXPENS	-19.68213	0.000
SAFEWAT	-24.82941	0.021

Conclusion: Treating Tap Water

- Those with higher mortality risk perceptions reported higher treatment expenditures than those with lower mortality risk perceptions
- Homeownership is weakly positive and significant meaning that renting had a slight influence on treatment expenditures in the positive.
- If respondents stated that treatment was too expensive, this reduced their reported expenditures significantly.
- Respondents with higher ratings of their drinking water safety reported lower treatment expenditures than those with lower drinking water safety ratings.

Conclusion continued

- The logit models used to analyze the decisions to participate in the survey, to treat tap water and to purchase bottled water failed to provide sufficient evidence to support the other hypotheses due to the inaccurate applications these models to the data.
- Reported expenditures are a function of respondents' risk perceptions.

Conclusion and Application

- Ideas and conclusions described here may be transferable to other water quality contaminants

Questions

The background is a deep blue gradient that transitions from a lighter, almost white glow on the left side to a darker blue on the right. The surface has a subtle, rippling texture, suggesting water or a similar fluid medium. The overall effect is serene and clean.