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Arsenic in private well water part 1 of 3: Impact of the New Jersey Private Well Testing Act on household testing and mitigation behavior

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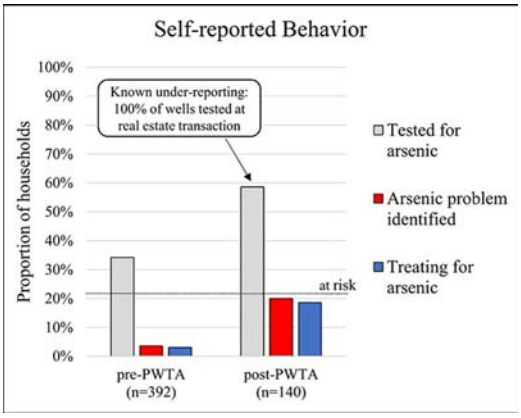
HIGHLIGHTS

- The impact of NJ legislation on private well testing and treatment is investigated
- Randomly selected well owners purchasing homes before and after the Act were surveyed
- Without required testing only 1 of 5 wells exceeding the arsenic MCL is identified
- Required arsenic testing reduces socioeconomic disparities, benefits children
- To maximize PWTA benefits, more support for households after testing is necessary

GRAPHICAL ABSTRACT



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ABSTRACT

Regularly ingesting water with elevated arsenic increases adverse health risks. Since September 2002, the NJ Private Well Testing Act (PWTA) has required testing untreated well water for arsenic during real estate transactions in 12 counties. Its implementation provides an opportunity to investigate the effects of policy intervention on well testing and treatment behavior. Here we analyze results of a survey mailed to 1943 random addresses (37% response), including responses from 502 private well households who purchased their homes prior to PWTA commencement and 168 who purchased after. We find the PWTA has significantly increased arsenic testing rates in an area where 21% of wells contain arsenic above the 5 μg/L NJ drinking water standard. The PWTA has allowed identification of more wells with arsenic (20% of post-PWTA vs. 4% of pre-PWTA households) and more treatment for arsenic (19% of post-PWTA vs. 3% of pre-PWTA households). Such an Act is a partial answer to significant socioeconomic disparities in testing observed among households for whom it is not required. Additionally residents purchasing homes since 2002 are younger and disproportionately more likely to have children in their household (60% vs. 32%), a priority group given their particular vulnerability to effects of arsenic. Despite more wells tested under the PWTA, post-PWTA well owners forget or misremember arsenic test results

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more often, are more likely to report not knowing what kind of treatment they are using, and are not reporting better maintenance or monitoring of their treatment systems than pre-PWTA households. This suggests serious challenges to reducing arsenic exposure remain even when testing is a requirement. Furthermore, only a fraction of wells have been tested under the PWTA due to the slow pace of housing turnover. We recommend more public resources be made available to support private well testing among socially and biologically vulnerable groups.

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1. Introduction

Arsenic is a toxic element known to increase the risks for adverse health effects in people who regularly drink water with elevated levels (Ravenscroft et al., 2009). Arsenic in water is colorless, odorless, and tasteless and its presence can only be identified by specific testing. Naturally occurring concentrations in groundwater are generally below levels considered an acute risk for poisoning, but over time chronic exposure can have serious consequences. Dose-dependent relationships have been observed for a range of conditions including cancers of the skin, bladder, kidney, and lung (Chen et al., 1988, 1992; Smith et al., 1998), as well as cardiovascular disease, pulmonary disease, diabetes mellitus and neuropathy (Smith et al., 2000). Of great concern are the consequences of exposure that begins early in life or during pregnancy. Risks include reduced birth weight and impaired cognitive function, as well as significantly higher risks of impaired lung function, death from renal and lung cancer, lung disease, and acute myocardial infarction later in life (Smith and Steinmaus, 2009; Dauphiné et al., 2011; Yuan et al., 2007, 2010; Wasserman et al., 2014). For this reason families with pregnant women or young children who are at greater risk for developmental effects and adverse outcomes later in life should be more vigilant about the quality of their well water.

Evidence of health impacts from chronic exposure to arsenic led the United States Environmental Protection Agency (USEPA) to adopt a standard for arsenic in drinking water of 10 μg/L in 2001, replacing the old maximum contaminant level (MCL) of 50 μg/L (United States Environmental Protection Agency (USEPA), 2001). Public water systems were given several years to comply and this "arsenic rule" became enforceable in 2006. In 2004 the state of New Jersey (NJ) updated the NJ Safe Drinking Water Act by adopting its own more stringent standard of 5 μg/L, the most protective in the nation, which also became effective in 2006 (New Jersey Department of Environmental Protection (NJDEP), 2004). Although public water supply systems are regulated to meet these government drinking water standards for arsenic and other contaminants, private well water is not. Throughout the United States (U.S.) any regulation for arsenic testing of existing private wells is rare. States, aside from New Jersey and Oregon (ORS448.271), do not require arsenic testing of private wells during property transfer. New Jersey's Private Well Testing Act (PWTA, N.J.S.A. 58:12A-26 et seq.) commenced in September 2002 and requires testing of untreated groundwater for a variety of parameters prior to real estate transactions, including home sales and rentals. Arsenic testing is required in 12 counties in the northern and central part of the state (Fig. 1) where naturally occurring arsenic concentrations as high as 250 μg/L occur in the bedrock aquifers of the Newark Basin (Serfes et al., 2005). About one million people (11% of population) in New Jersey rely on private well water for drinking (Maupin et al., 2014). Little has been known about the influence the PWTA has had on well testing and water treatment behavior for arsenic or other contaminants in New Jersey.

Laws, regulations, and guidelines, have the potential to improve public health. The ten great public health achievements of the 20th century in the United States identified by the Centers for Disease Control and Prevention (CDC) were each influenced by policy changes or regulations (Centers for Disease Control and Prevention, 1999). These include seat belt laws, workplace and food safety regulations, anti-smoking legislation and taxation, and fluoridation of drinking water. The quality of publicly-supplied drinking water in the United States is among the best in the world, in part because it is regulated by the USEPA (Centers for Disease Control and Prevention, 2009). There is increasing recognition that further changes in policy and the environment will be necessary to cultivate and maintain the individual-level behavior changes needed to combat chronic diseases (Schmid et al., 1995). Private well water in the U.S. is still widely unregulated, relying on individuals to be aware, willing, and capable to monitor, improve, and maintain the safety of their drinking water. Over 13 million, mostly rural, U.S. households regularly depend on private wells for their drinking water (U.S. Census Bureau, 2015). Local community engagement efforts to promote testing for arsenic are limited in scale and in success (Renaud et al., 2011; Severtson et al., 2006). Policy-level intervention will be a required component of any strategy to eliminate exposure to arsenic from private well drinking water (Zheng and Ayotte, 2015). The implementation of the PWTA in NJ provides the opportunity to investigate the effects of a private well testing policy intervention on testing and water treatment behavior.

Here we present the findings from a mailed survey of private well households in 17 towns of northern New Jersey covered by the PWTA's requirement for arsenic testing. Addresses were selected randomly and then matched to PWTA records where available, allowing comparison of self-reported testing and treatment behavior between households who have faced the requirement to test and those who have not, in order to gain insight into the potential effectiveness of the regulation.

2. Methods

2.1. Study area

The study area covers 17 towns in northern New Jersey (Table 1), selected for arsenic occurrence, based on the percentage of wells tested under the PWTA with >5 μg/L arsenic, and majority private well water supply, based on the percentage of households using private wells in 1990 (U.S. Census Bureau, 1993). The 2010 census shows a combined population of 144,132 and overall 76% of households in this area are estimated to rely on private well water (U.S. Census Bureau, 1993; U.S. Census Bureau). PWTA records of 10,278 wells in these towns performed as of April 2014 show that 20.8% of wells tested exceed the New Jersey MCL of 5 μg/L and 7.1% exceed the federal MCL of 10 μg/L. Based on these numbers we estimate there may be 22,784 people in these towns drinking from wells with arsenic concentrations exceeding 5 μg/L, and 7777 drinking from wells with arsenic concentrations over 10 μg/L. The maximum arsenic concentration recorded under the PWTA was 254 μg/L from Hopewell, while the 75th percentile value was 4.6 μg/L and median value was 2.0 μg/L, using the Kaplan-Meier survival analysis approach for censored data (Helsel, 2012).

2.2. Survey instrument

Participants completed a 35 question survey on their water testing and treatment practices, preferences, and opinions, as well as basic demographic information. This questionnaire was a modified version of one developed for our previous study in Maine, with a similar section designed to measure the RANAS (Risk, Attitude, Norm, Ability, Self-regulation) factors (Mosler, 2012) that may influence testing and treatment behaviors through a series of statements to which the respondent indicated agreement on a scale of 1 (strongly disagree) to 6 (strongly

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