Social factors shaping the adoption of lead-filtering point-of-use systems: an observational study of an MTurk sample

Noelle Chesley, Helen Meier, Jake Luo, Immaculate Apchemengich and W. Hobart Davies

ABSTRACT

Some municipalities are promoting lead-filtering point-of-use (POU) systems to minimize the risk of lead exposure through drinking water, often targeting use at racial minorities and low-income households. However, links among social inequality markers and adoption of these systems are not well understood. Survey data on adoption and use of POU systems were collected from a U.S. Mechanical Turk (MTurk) sample ($N = 2,867$) in March 2018. We use logistic regression to assess the association of race/ethnicity, socioeconomic status (SES), and lead-filtering POU adoption. We also examined key health behaviors related to POU systems. We found that race and SES are indirectly predictive of lead-filtering POU adoption through the propensity of some respondents to report a residence with a lead service line and levels of concern and knowledge about lead exposure. In addition, individuals with similar levels of concern about lead in water have lower odds of adopting a POU system if they have lower, rather than higher, incomes. Among POU adopters, while confidence in correct use of these devices was relatively high, the frequency of filtered water use for cooking was lower than drinking frequency. Overall, these findings inform health policies aimed at mitigating risk of lead exposure through water.

Key words | drinking water, environmental health, lead, Mechanical Turk, point-of-use filtration, water policy

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INTRODUCTION

Lead exposure is not a new public health problem. Lead is a known neurotoxin with well-documented negative health impacts that particularly affect young children's cognition (Levin *et al.* 2008), behavior (Feigenbaum & Muller 2016; Muller *et al.* 2018), and growth (Frisancho & Ryan 1991; Kim *et al.* 1995). Infants consuming formula made with lead-tainted water can be at risk for elevated blood lead levels (BLLs) (Triantafyllidou *et al.* 2014; AAP 2016), and previous research suggests that children bear the vast majority of health consequences related to exposure (Pruss-Ustun *et al.* 2011). Adults also experience physical (National Toxicology Program 2012) and mental (Weuve *et al.* 2009; Farooqui *et al.* 2016) health consequences associated with exposure, and exposure remains a particular concern for pregnant and lactating women (Brown & Margolis 2012).

Ingestion of lead through paint, dust, soil, and water are all known sources of lead exposure (Muller *et al.* 2018). Even so, lead in water has often been overlooked as an important source of exposure (Renner 2010; Triantafyllidou & Edwards 2012; American Academy of Pediatrics (AAP) 2016; Pieper

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et al. 2019). This is changing as city names like Flint and Newark, now synonymous with recent water crises, illustrate that lead exposure through drinking water impacts public health (Hanna-Attisha *et al.* 2016; Corasanti *et al.* 2019). As stories like these make the national news, concerns about lead in water are growing in cities across the USA (Renner 2010; Fears 2016; Hawthorne 2016; Pierce & Gonzalez 2016; Wines & Schwartz 2016; Hallett 2017; Plumer & Popovich 2018).

Lead can enter the water system in numerous ways. A 2007 report documents that almost 43,000 pounds of lead were released nationwide into water in 2004. This may be an underestimate as not all water facilities are required to report such chemical releases (U.S. Department of Health and Human Services (HHS) 2007). A 2016 report finds that over 18 million people in the USA were served by community water systems that violated rules governing lead in drinking water (Olson & Fedinick 2016). In addition, many communities have lead-based public and private pipes, a key risk factor for lead exposure (Sobsey 2006; Levin *et al.* 2008; Renner 2009). Estimates of the number of lead service lines (LSLs) across the nation vary. Cornwall *et al.* (2016) estimated that 6.1 million LSLs provided drinking water to 15–22 million people in the USA in 2016 (Cornwall *et al.* 2016), while the Environmental Protection Agency (EPA) estimates that somewhere between 6.5 and 10 million homes have LSLs that are at least partially made of lead (EPA 2016). Furthermore, although the issue of pipes is often framed as a legacy issue – the result of an aging, lead-based water infrastructure – new plumbing systems can also contain pipes or fittings that introduce lead contamination (Triantafyllidou & Edwards 2012). Overall, concerns about lead exposure through drinking water are increasing both in the public and among health professionals.

Social inequality and lead exposure

Like many other environmental health hazards, lead exposure through drinking water is linked to social inequality (Muller *et al.* 2018). Exposure is higher among racial/ethnic minorities and low socioeconomic status (SES) individuals and contributes to health disparities (Levin *et al.* 2008; Jacobs 2011; Cassidy-Bushrow *et al.* 2017; Muller *et al.* 2018). The central source of most drinking water exposure occurs through deteriorating lead-based pipes used in public and private water delivery systems (Renner 2009; Pieper *et al.* 2019). LSLs that are part of municipal water delivery systems are concentrated in particular geographic regions of the USA (Cornwall *et al.* 2016). Many systems are old with deteriorating pipes, making LSLs a key source of most lead in drinking water (Pieper *et al.* 2019). In addition, homes built prior to 1960 (or 1986 in some areas) are more likely to have internal lead plumbing (Sobsey 2006; Renner 2009), although newer homes can also have plumbing that contains lead (Pieper *et al.* 2019). Residential segregation patterns in many areas mean that racial or ethnic minorities and low-SES individuals are more likely to be exposed to lead in drinking water because of where they live and work (Levin *et al.* 2008; Jacobs 2011; Hanna-Attisha *et al.* 2016; Muller *et al.* 2018) or go to daycare or school (Triantafyllidou & Edwards 2012). Overall, as Muller *et al.* (2018) have noted, the consequences of unequal lead exposure through segregation processes in housing, education, and employment intensify already existing racial/ethnic and SES inequality, including health and social disparities related to disparate lead exposure.

Furthermore, knowledge and attitudes about environmental health risks and whether and how to address them can vary across racial/ethnic and SES groups (Pierce & Gonzalez 2016; Noy & O'Brien 2018). Social influences linked to race/ethnicity, such as differences in levels of trust of health institutions and policy (Corbie-Smith *et al.* 2002; Morone 2016) and varying levels of awareness and concern about environmental exposures (Greenberg 2005; Macias 2016), may influence point-of-use (POU) filter adoption. Furthermore, SES can indicate whether financial resources are available to support ongoing healthy behaviors (Muller *et al.* 2018) such as purchasing POU systems and replacing filters over time. SES differences in beliefs about the importance of taking action to address water concerns (Zheng & Flanagan 2017) may also hinder the adoption of POU water filtration systems to address potential lead exposures. Research suggests that perceptions about water quality appear most influenced by social inequality markers such as race/ethnicity and SES (Pierce & Gonzalez 2016). However, racial/ethnic and SES variation in lead-filtering POU adoption or differences in knowledge or key attitudes related to lead exposure or POU use have not been explicitly addressed in POU filter research.

Policy recommendations and the efficacy of POU water filters

In response to concerns about potential exposure to lead-contaminated drinking water, one public health action is to recommend or supply 'POU' water filtration systems that are certified to remove lead (e.g., ANSI/NSF 53 certification) to at-risk individuals (e.g., Greater Cincinnati Water Works 2018; Pieper *et al.* 2019; City of Evanston n.d.; Milwaukee Health Department n.d.). These systems are provided to (or purchased by) individuals and often include recommendations to adopt faucet-mount or on- or under-the-counter devices as well as pour-through pitchers (e.g., City of Evanston n.d.; Milwaukee Health Department n.d.).

Research on the efficacy of POU filters as a public health intervention aimed at preventing lead exposure in real-world conditions is limited, but promising (Deshommes *et al.* 2010; AAP 2016; Brown *et al.* 2017; Bosscher *et al.* 2019; Pieper *et al.* 2019). A bench study comparing pour-through, faucet-mount, and under-the-counter water filtration systems conducted in a laboratory setting indicated that POU devices do reduce lead in drinking water (Deshommes *et al.* 2010). Deshommes *et al.* (2012) also studied the effectiveness of under-the-sink POUs that were selected, installed, and monitored by experts and found that these devices can reduce the amount of lead in drinking water in large buildings. A residential study conducted in Flint, MI in 2015 assessed the effectiveness of faucet-mount filters selected, installed, and monitored by experts. Researchers compared lead levels in drinking water in residences and commercial locations with and without filters using a matched design (Bosscher *et al.* 2019). Overall, lower concentrations of lead in drinking water were observed in geographic areas in which individuals were actively using POU faucet-mount systems. While this latter study provides some evidence that POU products can be effective in removing lead from drinking water in household (HH) settings, very little research examining how social, behavioral, or attitudinal factors may shape voluntary adoption and/or proper use of POU products has been conducted.

Such research is critically important because the long-term efficacy of lead-filtering POU products depends upon proper product selection, installation, maintenance, and use over time (AAP 2016; Pieper *et al.* 2019). We know very little about whether individual consumers understand the need to purchase lead-certified filtering systems, or, once purchased, install and maintain them correctly, since the few studies that have tested HH POU filter use have provided the correct systems to users, with experts installing these systems and monitoring their use. None of these prior studies examined the factors that pushed individuals to adopt lead-filtering POU systems on their own, or measured behavior changes in HHs, such as the consistency with which individuals in the HH are changing the filter or using filtered water for drinking or cooking, which are important behaviors if limiting lead exposure through water is a goal (Renner 2010).

Research questions

Given the clear links between markers of social inequality, such as racial/ethnic minority status and SES, and environmental exposures and attitudes, examining the potential for variation in adoption of, or experiences with, lead-filtering POU devices among key groups is both critical and missing in previous work. To address these gaps, we analyze survey data drawn from a sample of Americans to investigate two central research questions. First, is lead-filtering POU adoption patterned by general markers of inequality like race, ethnicity, or SES? Second, if there are connections among race, ethnicity, SES, and POU adoption, are these largely explained by: (1) greater exposure to lead-based plumbing or (2) varying attitudes or knowledge about the risks associated with lead exposure? We also explore how users of lead-filtering POU systems use them once adopted, and whether attitudes or behaviors related to use vary by minority or SES. Since a number of municipalities across the USA recommend voluntary adoption of POU devices to minimize the risk of lead exposure through drinking water, elucidating the social and behavioral factors that underlie POU adoption for this purpose is critically needed.

METHODS

Sample

We utilized unique survey data collected from a U.S. sample of Mechanical Turk (MTurk) respondents ($N=$ 2,867) in March 2018 to investigate the social and attitudinal factors that shape adoption of POU water filtration systems among U.S. consumers. MTurk is an online crowdsourcing labor market coordinated by Amazon.com. Individuals and organizations (requesters) use the platform to hire individuals to complete tasks (called 'Human Intelligence Tasks' or HITs), including completing research tasks such as surveys. The use of MTurk samples for research is growing across disciplines (Buhrmester *et al.* 2011), including public health (Mortensen & Hughes 2017). Our analysis focused on individuals who reported using a POU filter for any reason ($N=1{,}526$; 53%) or who reported using a POU that filters lead from drinking water ($N=650$; 23%). See the Supplementary Material for more information about the sample.

Procedures

We designed, tested, and administered a survey that measured a series of attitudes and behaviors related to water quality and the use of POU water filtration devices. The study design was approved by the University of Wisconsin-Milwaukee Institutional Review Board (#18.195). The task was advertised to MTurkers as a public opinion survey targeting views about drinking water that would take 5–7 min to complete. Respondents were required to have a U.S. IP address and a HIT approval rate greater than or equal to 95 in order to participate. The HIT approval rate is an indicator that a research participant has submitted high-quality work on previous MTurk assignments. We paid participants $0.50 for a completed survey. We conducted the survey over a period of 5 days on both weekdays and weekends and at different times of day (morning, afternoon, and evening) to ensure the most diverse pool of respondents possible (Casey *et al.* 2017).

Measures

POU filter adoption

Respondents were asked two key questions about their POU adoption: '*The next set of questions are about the use of water filters. These include water filters that are built into, or can be attached to, a faucet in your residence to filter your drinking water, or pitchers that have a filter inserted in them that can be filled with tap water. Do you use one or more water filters at home?*' (yes, no). If a respondent replied 'yes' to this question, they were asked whether '… *any filters you use in your home remove lead from your tap drinking water*?' (yes, no, don't know). This latter variable is recoded to denote individuals who self-report lead-filtering POU use (1) versus otherwise (0).

Social inequality indicators: race, ethnicity, and SES

We use both race and Hispanic ethnicity, as well as SES indicators to tap social factors linked to inequality. Race was measured categorically as Non-Hispanic (NH) White (reference), NH Black, NH Asian, NH Other, and Multiracial (two or more races selected). Hispanic identification was measured dichotomously (yes/no; can be any race). SES was measured through a respondent's level of formal education (has college degree or higher (1) versus otherwise (0)) and HH income. Income was measured categorically as HH income less than $50 K versus $50 K or greater after verifying that more gradation in income categories did not contribute to understanding income effects in models.

Presence of lead plumbing

The presence of lead pipes in water delivery is a risk factor for lead exposure. Exposure to residential lead plumbing is also patterned by race/ethnicity and SES (Jacobs 2011; Muller *et al.* 2018). We asked respondents first whether their home is '… *connected to the local or private water supply by lead pipes?*' and next whether their home contains '… *plumbing fixtures (pipes, solder, faucets) that are made with or contain lead?*' Possible responses to both questions were 'yes', 'no', or 'don't know'.

Concern/knowledge about lead in drinking water

Respondents rated their level of concern (1 = not concerned to 5 = extremely concerned) about consuming lead through drinking tap water for: (1) themselves or (2) others in the home. These items were highly correlated ($r = 0.89$; $p < 0.001$) and behaved similarly in models, so we averaged responses to create a single measure of concern. An additional question asked respondents to rate their level of knowledge about the health effects of consuming lead (1 = not knowledgeable to 5 = extremely knowledgeable).

Attitudes/behaviors of filter users/non-users

Individuals who reported any POU use were asked about their level of confidence in their use (*'How confident are you that you are using your water filter(s) in a way that maximizes the safety of your filtered drinking water'*; 1 = not confident at all to 5 = extremely confident). We also asked these individuals to rate their frequency of use of filtered water for: (1) drinking or (2) cooking (1 = never to 5 = all of the time). Among those that reported no POU filter use, we asked respondents to note their reasons why, choosing from a list of reasons that incorporated the expense or complexity of filter use, among other reasons.

Statistical controls

In addition to including measures of race/ethnicity, education, and HH income (described above), Levay *et al.* (2016) recommend controlling for age (in years), gender (1 = female), marital status (1 = married/cohabiting and 0 = never married/divorced/widowed/separated), religion (measured categorically, respondents could select more than one religious description), political ideology (1 = extremely liberal to 7 = extremely conservative), and partisanship (1 = strong democrat to 7 = strong republican) in MTurk samples. Question wording for religion, political ideology, and partisanship is adopted from Levay *et al.* (2016). In addition to these controls, we also control for survey completion on a weekday (versus weekend) and time of day of completion (morning, afternoon, and evening), as previous research demonstrates that both day of week and time of day can affect responses in observational studies like this one (Casey *et al.* 2017). The Supplementary material contains a complete copy of the survey with exact question wording and possible response categories.

Analysis

Our analysis proceeded in four steps. We began by generating descriptive statistics for our full U.S. sample ($N = 2,867$), as well as the subsample of POU adopters (any reason; $n = 1,526$) and lead-filtering POU adopters ($n = 650$) (Table 1). The Supplementary material provides further details on the sample, including a comparison of our full sample to U.S. Census estimates on select characteristics to help assess sample quality. Second, we investigated bivariate relationships among race, ethnicity, SES, exposure to lead plumbing, and levels of concern about lead in drinking water as well as self-reported knowledge about the health effects of lead to assess whether inequality markers appeared to pattern structural reasons for possible POU use (such as living in a home with lead pipes) or attitudes and knowledge about lead (Table 2). Our next set of analyses (Table 3) documented results from logistic regression models that: (1) estimated the effects of inequality markers (race, ethnicity, and SES) on the likelihood of lead-filtering POU adoption and (2) assessed the mediating effects of structural factors (self-reported exposure via a LSL or internal lead plumbing) and levels of concern or knowledge about lead on the likelihood that an individual reports lead-filtering POU use. All models were estimated on complete cases using STATA 15.0 (StataCorp 2015). All continuous variables were mean-centered in the regression analysis. Missing cases were less than 2% of the sample and were not systematically concentrated (see Table 1). We end by providing further descriptive analyses about the attitudes and behaviors of lead-filtering POU adopters and POU filter non-adopters.

RESULTS

Key sample characteristics of POU adopters

Table 1 indicates that about 53% of the MTurk sample reported adopting a POU filtration system for any reason,

Table 1 | Descriptive statistics comparing full sample, subsample of POU users (any reason), and subsample of lead-filtering POU users

	Full sample ($N = 2,867$)			Any POU ($N = 1,526$)			POU lead ($N = 650$)		
Characteristic	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
POU adoption?									
% Has POU	0.532	0.499	2,866						
% POU filters lead (asked of % reporting POU)	0.426	0.495	1,526	0.426	0.495	1,526			
Exposure risk: lead plumbing									
% No, LSL	0.338	0.473	2,867	0.335	0.472	1,526	0.303	0.460	650
% Yes, LSL	0.089	0.285	2,867	0.109	0.311	1,526	0.155	0.363	650
% DK, LSL	0.573	0.495	2,867	0.556	0.497	1,526	0.542	0.499	650
% No, internal lead plumb	0.426	0.495	2,864	0.432	0.496	1,525	0.418	0.494	649
% Yes, internal lead plumb	0.075	0.264	2,864	0.091	0.288	1,525	0.136	0.343	649
% DK, internal lead plumb	0.498	0.500	2,864	0.477	0.500	1,525	0.447	0.498	649
Attitudes about lead in water									
Level of concern about lead in water (1 = low; 5 = high)	2.254	1.241	2,867	2.362	1.258	1,526	2.746	1.298	650
Knowledge of health effects of lead (1 = low; 5 = high)	2.605	1.013	2,859	2.671	1.013	1,522	2.890	1.032	648
Inequality marker: race/ethnicity									
% NH White	0.804	0.397	2,863	0.794	0.404	1,523	0.754	0.431	650
% NH Black	0.077	0.266	2,863	0.073	0.260	1,523	0.094	0.292	650
% NH Asian	0.063	0.243	2,863	0.074	0.261	1,523	0.088	0.283	650
% NH Multi	0.039	0.193	2,863	0.039	0.193	1,523	0.043	0.203	650
% NH Other	0.018	0.132	2,863	0.020	0.141	1,523	0.022	0.145	650
% Hispanic	0.071	0.257	2,865	0.082	0.274	1,525	0.100	0.300	650
Inequality marker: SES									
% with college degree	0.520	0.500	2,862	0.563	0.496	1,522	0.558	0.497	650
% with HH income $50 K or greater	0.508	0.500	2,867	0.568	0.495	1,526	0.589	0.492	650
Statistical controls									
Age	38.783	12.255	2,863	38.188	12.118	1,524	37.637	12.113	650
% Female	0.540	0.498	2,860	0.550	0.498	1,521	0.512	0.500	650
% Partnered	0.555	0.497	2,865	0.594	0.491	1,524	0.606	0.489	650
% Living with child(ren) under 6	0.180	0.385	2,861	0.190	0.392	1,523	0.203	0.403	650
% Employed	0.776	0.417	2,865	0.801	0.400	1,525	0.828	0.378	650
% Own residence	0.548	0.498	2,867	0.592	0.492	1,526	0.591	0.492	650
% Urban	0.272	0.445	2,866	0.261	0.439	1,525	0.273	0.446	649
% Suburban	0.523	0.500	2,866	0.557	0.497	1,525	0.572	0.495	649
% Rural	0.204	0.403	2,866	0.182	0.386	1,525	0.156	0.363	649
% Religious progressive	0.146	0.353	2,867	0.147	0.355	1,526	0.158	0.365	650
% Religious non-traditional	0.071	0.257	2,867	0.069	0.254	1,526	0.066	0.249	650
% Secular	0.062	0.241	2,867	0.072	0.259	1,526	0.075	0.264	650
% Agnostic	0.181	0.385	2,867	0.173	0.378	1,526	0.152	0.360	650
% Atheist	0.159	0.365	2,867	0.149	0.357	1,526	0.135	0.342	650

(*continued*)

Table 1 | continued

	Full sample (*N* = 2,867)			Any POU (*N* = 1,526)			POU lead (*N* = 650)		
Characteristic	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
% Spiritual	0.246	0.431	2,867	0.248	0.432	1,526	0.266	0.442	650
% None of the above religious categories	0.202	0.401	2,867	0.199	0.400	1,526	0.194	0.396	650
Extremely liberal (1) to conservative (7)	3.509	1.716	2,864	3.540	1.716	1,525	3.700	1.710	649
Strong democrat (1) to republican (7)	3.909	2.082	2,860	3.925	2.092	1,522	4.045	2.102	648
% Completed survey on weekday (versus weekend)	0.694	0.461	2,867	0.691	0.462	1,526	0.720	0.449	650
% Completed survey in morning	0.697	0.460	2,867	0.686	0.464	1,526	0.652	0.477	650
% Completed survey in afternoon	0.213	0.409	2,867	0.219	0.414	1,526	0.234	0.424	650
% Completed survey in evening	0.090	0.287	2,866	0.095	0.293	1,526	0.114	0.318	650

Source: Perceptions of water quality, safety, and point-of-use filtration among Americans survey, March 2018.

while about 23% reported using a POU system that filters lead from drinking water. Knowledge about exposure through plumbing systems was limited. About 9% of the sample self-reported living in a residence with an LSL, while about 8% reported living in a residence with internal lead plumbing. Of those that reported an LSL, about 58% also said that their main residence also had internal lead plumbing. However, it was much more common for respondents to report that they did not know if the water service line to their residence contained lead (57%) or if the plumbing inside of their residence contained lead (50%). It is notable that the number of respondents who reported an LSL or internal lead plumbing increased if they also reported adopting a lead-filtering POU system (16 and 14%, respectively).

We also see changes in levels of concern about lead in drinking water as well as self-reported knowledge about the health effects of lead as we move from descriptive statistics of the full sample (2.3 and 2.6, respectively) to the subsample of lead-filtering POU adopters (2.7 and 2.9, respectively). While levels of both concern and knowledge are relatively low overall (a score of '3' would indicate 'concern' or 'knowledgeable'), self-reported levels of concern are noticeably higher in the lead-filtering POU subsample.

Racial/ethnic identification shows that most respondents in the full MTurk sample identified as NH White (80%), followed by NH Black (8%), NH Asian (6%), Multiracial (4%), or Other (2%). About 7% of the sample identified as Hispanic (any race). However, we do see slightly higher concentrations of racial and ethnic minorities in the subsample that self-reported using a lead-filtering POU system. In terms of education, 52% reported having a college degree or higher and 51% of the sample had a HH income of $50,000 or higher. We see higher percentages of college degree holders or upper-income individuals in the subsample of lead-filtering POU adopters (56 and 59%, respectively).

The average survey respondent was 39 years old, and 54% of the sample was female. Most (56%) were married or cohabiting and 78% report being employed. A majority were homeowners (55%) who identified as living in suburban (52%) rather than urban (27%) or rural (20%) areas. There was variation in religious beliefs, political characteristics, and day and time of survey completion.

Bivariate patterns in exposure and attitudes

We conducted a series of bivariate analyses (chi square tests of association and ANOVA) to investigate relationships among race, ethnicity, reports of LSLs or internal lead plumbing, and attitudes/knowledge about lead. Table 2 documents the bivariate statistics, examining relationships in the subsample of general POU adopters as well as the subsample of lead-filtering POU adopters. In the first set of columns in Table 2, we see distributions of LSL reports by race and ethnicity for both 'Any POU Use' respondents and 'Lead-Filtering POU Use' respondents. These bivariate statistics indicate that higher proportions of Black and

Table 2 | Bivariate patterns among race/ethnicity, SES, presence of lead plumbing, and lead attitudes/knowledge among POU filter users

	Lead service line?			Internal lead plumbing/ solder?			Level of concern		Level of knowledge	
Inequality markers	**% No**	**% Yes**	**% DK**	**% No**	**% Yes**	**% DK**	**Mean**	**SD**	**Mean**	**SD**
Any POU use ($N = 1,501$)										
Race										
NH Black	20.9	30.0	49.1[a]	32.7	29.1	38.2[b]	2.70	1.27[d,e]	2.98	1.10[c]
NH Asian	20.2	22.9	56.9	28.4	17.4	54.1	2.39	1.33	2.62	1.09
NH Multi	28.6	8.9	62.5	42.9	5.4	51.8	2.45	1.30	2.80	1.15
NH Other	45.2	19.4	35.5	41.9	12.9	45.2	2.97	1.28	3.03	1.11
NH White	35.6	7.8	56.7	45.4	6.4	48.2	2.21	1.17	2.63	0.98
Ethnicity										
NH (any race)	34.1	9.5	56.4[a]	44.1	7.8	48.0[b]	2.24	1.19[a]	2.66	1.01
Hispanic (any race)	24.4	25.2	50.4	30.9	22.0	47.2	2.78	1.32	2.83	1.08
SES										
No college degree	33.5	10.2	56.3	44.3	9.6	46.1	2.45	1.24[a]	2.59	0.99
College degree	33.2	11.3	55.6	42.1	8.5	49.4	2.15	1.16	2.74	1.03[b]
HH income less than \$50 K	30.1	12.1	57.8[b]	36.7	10.7	52.6[a]	2.49	1.25[a]	2.65	1.04
HH income \$50 K or greater	35.8	9.8	54.4	47.8	7.7	44.5	2.13	1.15	2.69	0.99
Lead-filtering POU use ($N = 643$)										
Race										
NH Black	21.7	43.3	35.0[a]	21.7	43.3	35.0[a]	3.13	1.30[c]	3.37	1.09[c]
NH Asian	29.8	22.8	47.4	29.8	22.8	47.4	2.71	1.43	2.84	1.03
NH Multi	48.0	8.0	44.0	48.0	8.0	44.0	2.76	1.18	3.00	1.29
NH Other	57.1	14.3	28.6	57.1	14.3	28.6	3.18	1.30	3.14	1.10
NH White	45.0	9.0	46.0	45.0	9.0	46.0	2.56	1.21	2.83	1.00
Ethnicity										
NH (any race)	31.4	13.6	54.9[a]	43.2	11.2	45.6[a]	2.58	1.23[a]	2.88	1.03
Hispanic (any race)	20.3	32.8	46.9	29.7	34.4	35.9	3.22	1.28	3.02	1.08
SES										
No college degree	31.2	13.7	55.1	44.2	11.9	43.9	2.75	1.25	2.76	1.00[b]
College degree	29.6	17.0	53.4	39.9	14.8	45.3	2.56	1.25	2.99	1.05
HH income less than \$50 K	24.7	17.1	58.2[b]	34.2	15.6	50.2[b]	2.84	1.25[a]	2.86	1.03
HH income \$50 K or greater	34.2	14.5	51.3	47.1	12.1	40.8	2.51	1.24	2.92	1.04

Source: Perceptions of water quality, safety, and point-of-use filtration among Americans survey, March 2018.
[a]Chi-square/F-tests have $p < 0.001$.
[b]Chi-square/F-tests have $p < 0.05$.
[c]White–Black differences are significant, $p < 0.05$.
[d]White–Black differences are significant, $p < 0.01$.
[e]White–Other differences are significant, $p < 0.05$.

Hispanic individuals report living in a residence connected to an LSL ($p < 0.001$). There is a similar pattern in reports of internal lead plumbing ($p < 0.05$). In both subsamples, self-reporting living in a home with an LSL or internal lead plumbing is the least common response for the college educated and those with higher incomes.

Table 3 | Logistic regression results documenting the influence of race/ethnicity, SES, lead plumbing, and attitudes on likelihood of lead-filtering POU adoption, $N = 1{,}501$

	Model 1			Model 2			Model 3			Model 4		
Characteristic	**OR**	**SE**	**Prob**	**OR**	**SE**	**Prob**	**OR**	**SE**	**Prob**	**OR**	**SE**	**Prob**
Interaction terms												
HH income*level of concern							**1.247**	**0.122**	**0.024**	**1.250**	**0.122**	**0.023**
Exposure to lead plumbing (comparison is no)												
Yes, LSL				**1.776**	**0.404**	**0.012**				1.232	0.296	0.386
DK, LSL				1.281	0.189	0.093				1.173	0.182	0.305
Yes, internal lead plumbing				1.586	0.379	0.053				1.037	0.262	0.884
DK, internal lead plumbing				0.844	0.120	0.232				0.823	0.124	0.195
Attitudes/knowledge												
Level of concern about lead in water							1.375	0.097	**0.000**	1.359	0.100	**0.000**
Knowledge of health effects of lead							1.340	0.079	**0.000**	1.322	0.082	**0.000**
Race/ethnicity (NH White is comparison)												
NH Black	**1.716**	**0.361**	**0.010**	1.432	0.312	0.099	1.367	0.306	0.161	1.313	0.298	0.231
NH Asian	**1.690**	**0.355**	**0.013**	1.496	0.321	0.060	**1.583**	**0.352**	**0.039**	1.546	0.346	0.052
NH Multi	1.102	0.317	0.737	1.127	0.326	0.679	0.970	0.297	0.922	0.975	0.299	0.934
NH Other	1.005	0.391	0.989	1.008	0.395	0.984	0.694	0.281	0.367	0.711	0.287	0.398
% Hispanic (versus NH)	1.443	0.299	0.076	1.283	0.272	0.240	1.271	0.280	0.276	1.241	0.276	0.331
Inequality marker: SES												
College degree	0.885	0.101	0.285	0.901	0.104	0.366	0.935	0.113	0.581	0.947	0.115	0.655
HH income $50 K or greater	1.098	0.136	0.446	1.130	0.141	0.328	1.280	0.167	0.059	1.278	0.168	0.061
Statistical controls												
Age	0.996	0.005	0.467	0.997	0.005	0.565	0.997	0.005	0.549	0.997	0.005	0.542
Female	0.788	0.088	0.033	0.793	0.090	0.041	0.747	0.088	0.013	0.756	0.090	0.018
Partnered	1.139	0.141	0.291	1.146	0.143	0.275	1.128	0.145	0.351	1.122	0.146	0.376
Living with child(ren) under 6	1.060	0.155	0.690	1.028	0.152	0.850	0.989	0.151	0.940	0.985	0.151	0.923
Employed	1.253	0.176	0.108	1.189	0.169	0.223	1.052	0.155	0.730	1.040	0.153	0.789
Own residence	1.033	0.126	0.789	1.014	0.126	0.909	1.034	0.133	0.794	1.019	0.132	0.885
Urban (versus rural)	1.315	0.232	0.121	1.201	0.216	0.309	1.278	0.236	0.185	1.261	0.236	0.217
Suburban (versus rural)	1.273	0.191	0.107	1.228	0.186	0.175	1.282	0.201	0.113	1.274	0.201	0.124
Religious progressive	0.843	0.199	0.469	0.825	0.196	0.419	0.785	0.194	0.327	0.777	0.193	0.309
Religious non-traditional	0.731	0.202	0.258	0.753	0.210	0.310	0.731	0.212	0.279	0.737	0.215	0.295
Secular	0.872	0.221	0.590	0.890	0.228	0.648	0.874	0.233	0.614	0.870	0.233	0.602
Agnostic	0.617	0.149	0.046	0.653	0.160	0.081	0.630	0.161	0.070	0.637	0.164	0.079
Atheist	0.721	0.182	0.196	0.758	0.193	0.277	0.760	0.202	0.303	0.771	0.206	0.329
Spiritual	0.864	0.203	0.533	0.866	0.206	0.544	0.818	0.203	0.417	0.815	0.203	0.412
None of the above religious categories	0.641	0.164	0.083	0.657	0.170	0.105	0.686	0.185	0.163	0.687	0.186	0.166
Extremely liberal (1) to conservative (7)	1.091	0.045	0.034	1.074	0.045	0.086	1.087	0.047	0.056	1.083	0.047	0.069
Strong democrat (1) to republican (7)	1.014	0.032	0.663	1.021	0.033	0.520	1.005	0.033	0.891	1.009	0.034	0.797
Completed survey on weekday (versus weekend)	1.137	0.149	0.328	1.137	0.150	0.332	1.153	0.158	0.299	1.153	0.158	0.300

(*continued*)

Table 3 | continued

	Model 1			Model 2			Model 3			Model 4		
Characteristic	**OR**	**SE**	**Prob**	**OR**	**SE**	**Prob**	**OR**	**SE**	**Prob**	**OR**	**SE**	**Prob**
Completed survey in afternoon (versus morning)	1.133	0.162	0.385	1.179	0.170	0.256	1.166	0.174	0.303	1.178	0.177	0.275
Completed survey in evening (versus morning)	1.395	0.269	0.084	1.405	0.273	0.080	1.491	0.301	0.048	1.482	0.299	0.051
Constant	0.552	0.175	0.061	0.505	0.165	0.036	0.612	0.203	0.139	0.611	0.208	0.149

Source: Perceptions of water quality, safety, and point-of-use filtration among Americans survey, March 2018.
Bolded figures are significant at $p < 0.05$.

Survey respondents also self-reported how concerned they were about lead exposure through drinking water. Table 2 shows clear variation in levels of concern among individuals with key characteristics. Racial minorities all reported higher levels of concern about lead in drinking water than White individuals in both samples, although a post-hoc test of comparisons (Schfee) indicates that only White–Black ($p < 0.001$) and White–Other ($p < 0.05$) differences were statistically significant in the general POU sample (just White–Black differences are significant in the lead-filtering POU sample, $p < 0.05$). The pattern is similar among a key ethnic minority – Hispanics – who were more likely to report higher levels of concern about lead in water than NHs ($p < 0.05$) across samples. Finally, we found that levels of concern were higher among the less educated and those with lower incomes ($p < 0.001$), although the education differences were statistically significant in the 'Any POU Use' group only.

Lastly, we examined bivariate patterns in self-reports of knowledge about the health effects of lead. There was some similarity in racial patterns with individuals in Black, Multiracial, and 'Other' groups reporting higher levels of knowledge about the health effects of lead than White or Asian individuals in both subsamples, although post-hoc tests show that only Black–White differences were statistically significant ($p < 0.05$). We also observed higher levels of knowledge among Hispanics than NHs, although these differences were not statistically significant. College degree holders reported higher levels of knowledge about the health effects of lead than those without degrees in both subsamples ($p < 0.05$), as did higher-income individuals (although those differences are not statistically significant).

Logistic regression results

We build on the bivariate analysis presented in Table 2 by estimating a series of logistic regressions that allowed us to discern exactly how inequality markers like race, ethnicity, or SES, in combination, might influence the likelihood that individuals adopt lead-filtering POU systems following guidelines in Hosmer & Lemeshow (2000). Model 1 in Table 3 isolated the effects of race, ethnicity, and SES on likelihood of lead-filtering POU adoption, controlling for a range of other factors. Here, we saw that all racial and ethnic minorities were more likely to report use of lead-filtering POU systems than White individuals, although only Black–White and Asian–White comparisons were statistically significant. Black and Asian respondents report higher odds of using a lead-filtering POU system (72 and 69%, respectively; $p < 0.05$) than White respondents, controlling for all other variables in the model. There were no statistically significant effects of SES (education/income) on the odds of lead-filtering POU adoption.

Model 1 indicates that racial identification can matter when it comes to reporting the use of lead-filtering POU systems. Are there structural circumstances or other social characteristics that more precisely explain this association? Given the patterning of residential housing access by race/ethnicity across the USA described in the section 'Social Inequality and Lead Exposure', in Model 2 as shown in Table 3, we added information about knowledge of lead plumbing (LSL or internal plumbing) in a residence to our initial Model 1 specification. Including this information in the model eliminated the association among reporting Black or Asian race and the greater odds of lead-filtering

POU adoption observed in Model 1. We saw that individuals who reported living in a main residence with an LSL have 78% higher odds of adopting a lead-filtering POU than those who reported no LSL. The reduction in significance for Black and Asian racial identification when information on LSLs and lead plumbing was added to Model 1 is consistent with mediation. Overall, the results from Model 2 suggested that self-reported knowledge about LSLs mediates links between race and lead-filtering POU adoption.

However, given the bivariate patterns linking race and key attitudes about levels of concern and knowledge regarding lead, we might also wonder about the role of these attitudes in shaping POU adoption. We examined the role of concern and knowledge about lead on the odds of lead-filtering POU adoption in Model 3 as presented in Table 3. We first estimated a main effects model (not shown) which indicated that the effect of identifying as NH Black relative to NH White on the likelihood of lead-filtering POU adoption, while still positive, was no longer statistically significant. This pattern in regression coefficients was again indicative of mediation, suggesting that it was concern and knowledge about lead that explains the positive association between Black racial identification and lead-filtering POU adoption. However, the association between Asian racial identity and adoption remained both positive and statistically significant ($p < 0.05$), so attitudes alone do not explain all statistically significant race associations. Furthermore, we also saw a significant income effect emerge in the main effects model; individuals reporting incomes of $50 K or greater had 30% higher odds of reporting lead-filtering POU use than those with income less than $50 K, controlling for all other factors in the model.

Given these patterns in the main effects model, we estimated a version of Model 3 that included several interaction terms (Asian*Income, Concern*Income, and Knowledge*Income). Of these, only the Concern*Income interaction term was statistically significant. This is the version of the model that we include in Table 3. This interaction suggested that the effect of HH income on lead-filtering POU adoption depends on levels of concern (see Figure 1). Among those who say they are 'not concerned' about lead in drinking water (1), there is little difference in the odds of lead-filtering POU adoption (3.5%) between the two income groups. Among those who say they are 'concerned' about lead in drinking water (3), those living in higher-income HHs had 50% higher odds of adopting a lead-filtering POU system than those in the lower-income group. Among those that reported the highest levels of concern ('extremely concerned', 5), the odds of lead-filtering POU adoption are 133% higher for individuals with HH incomes $50 K or greater, compared with respondents in the lower-income group. Overall, this model suggested that it takes higher levels of concern to motivate lead-filtering POU adoption among lower-income individuals.

In Model 4 as shown in Table 3, we included information about race, ethnicity, SES, presence of lead

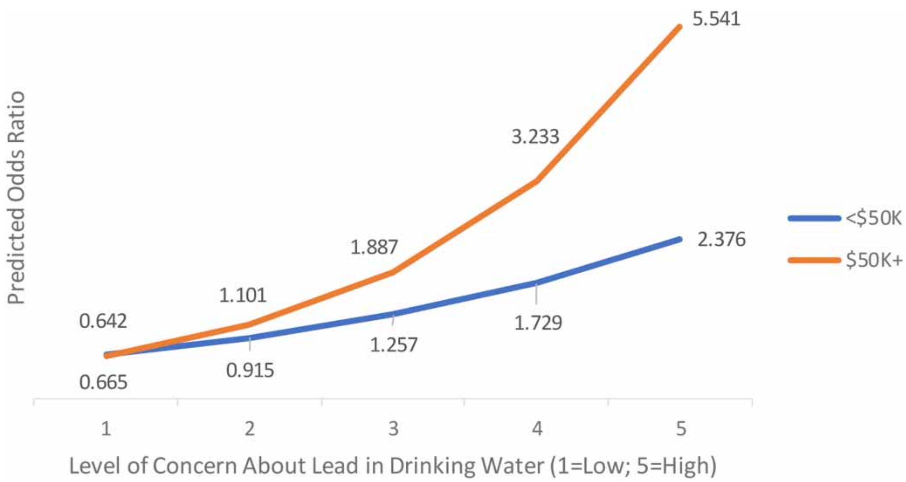

Figure 1 | Predicted odds ratios illustrating the interactive effect of level of concern and HH income on odds of lead-filtering POU adoption.

plumbing to or in the home, concern/knowledge about lead, and the concern × income interaction term. This model, which puts everything together, indicated that HH income and key attitudes are central mediating factors of racial differences in lead-filtering POU adoption. While the influence of reporting an LSL is not significant in this model, including these terms eliminates the significant, positive association between self-reporting an Asian racial identity and lead-filtering POU adoption. The predicted odds ratios from this model were not substantially different from those presented in Figure 1 (which used Model 3 results), so we do not show an additional figure. The interpretation, though, was the same. Controlling for all other factors in the model (including self-reporting exposure to an LSL or internal lead plumbing), individuals at the lowest levels of concern have similar odds of lead-filtering POU adoption. However, the difference in the odds of adoption between high- and low-income groups grows exponentially as levels of concern about lead in drinking water increase, with individuals that have higher incomes reporting higher odds of adoption than lower-income respondents at average or higher levels of concern. There was a main effect of knowledge about the health effects of lead, as well, apart from the role of concern, which influenced lead-filtering POU adoption. Each one-unit increase in knowledge on our scale (from 1 = 'no' knowledge to 5 = 'extreme' knowledge) resulted in a 32% increase in the odds of lead-filtering POU adoption. Overall, our model points to the patterning of knowledge about the health effects of lead, or income effects on the level of concern about lead in drinking water, that ultimately explains more blunt associations among race, SES, and lead-filtering POU adoption.

Descriptive analyses of attitudes and key behaviors among lead-filtering POU users

Table 4 documents bivariate patterns in key attitudes and self-reported behaviors that involve POU use. While our previous multivariate analyses (Table 3) demonstrated that self-reported lead-filtering POU adoption was patterned by race

Table 4 | Bivariate patterns among race/ethnicity, SES, and health attitudes and behaviors among lead-filtering POU adopters ($N = 643$)

	Confidence in correct filter use?			Frequency of drinking filtered water?		Frequency of cooking w/filtered water?	
Inequality markers	**Mean**	**SD**	**% Changing filter every 2–3 months**	**Mean**	**SD**	**Mean**	**SD**
Race							
NH Black	3.915	0.794	0.48	4.033	0.991	3.542	1.304
NH Asian	3.561	0.866	0.35	3.930	0.942	3.474	1.269
NH Multi	3.520	1.159	0.64	3.920	1.187	3.440	1.387
NH Other	3.857	1.099	0.43	3.571	1.016	4.143	1.099
NH White	3.719	0.905	0.50	4.156	0.977	3.207	1.367
Ethnicity							
NH (any race)	3.696	0.905	0.49	4.116	0.978	3.239	1.352[a]
Hispanic (any race)	3.921	0.931	0.45	3.984	1.076	3.766	1.306
SES							
No college degree	3.697	0.936^{+}	0.48	4.025	1.022^{+}	3.261	1.395
College degree	3.730	0.888	0.50	4.165	0.957	3.315	1.326
HH income less than $50 K	3.643	0.938	0.48	4.080	0.999	3.387	1.329
HH income $50 K or greater	3.770	0.886	0.49	4.118	0.982	3.224	1.372
Overall	3.718	0.909	0.49	4.103	0.988	3.291	1.356

Source: Perceptions of water quality, safety, and point-of-use filtration among Americans survey, March 2018.
[a]Difference is significant; $p < 0.01$.
$^{+}p < 0.10$.

and SES, once systems are adopted there is little variation in attitudes or behaviors around POU systems. Overall, lead-filtering POU users are generally confident that they are using the filtering system correctly, reporting a mean of 3.7 on our 5-point scale, suggesting that most feel confident or better in their use. When asked about the frequency of filter changes, the modal category was 'every 2–3 months,' with 49% of the lead-filtering POU sample reporting this level of frequency. Table 4 documents that patterns of filter changing with this level of frequency varied little by race, ethnicity, or SES. There was also a generally high level of use of filtered water for drinking among lead-filtering POU users (4.1 on average on a 5-point scale). We do see that reports of use of filtered water for cooking were a bit lower (about 3.3 on average), with the higher level of use of filtered water for this purpose among those that identify as Hispanic, compared with NHs (3.8 compared with 3.2; $p < 0.01$).

Reasons for no lead-filtering POU use

In our final analysis, we looked descriptively at respondents who reported being 'very' or 'extremely' concerned about consuming lead from drinking tap water at home, but who, nevertheless, told us they did not use a POU system of any kind ($n = 161$). Here, some of the most common reasons given for *not* using a POU filtering system included the expense involved (filters are too expensive to purchase and/or maintain; 43%), filters are too complex to install or maintain (5%), or both the expense and complexity of using filters is a reason for not using one (19%). Thus, expense, alone, or in conjunction with beliefs about the complexity of the devices, appears to play a key role in the rejection of lead-filtering POU technology, even at high levels of concern about lead in drinking water. This finding is consistent with the interaction effect between income and levels of concern about lead in water that we observed in our logistic regression models.

DISCUSSION

The water crises in Flint and Newark have increased concerns about lead in drinking water across the USA (Renner 2010; Fears 2016; Hawthorne 2016; Wines & Schwartz 2016; Hallett 2017; Plumer & Popovich 2018). Many cities have the same water crisis risk factors found in Flint and Newark, such as a high percentage of lead-based service lines and aging housing stock with lead plumbing (Fears 2016; Plumer & Popovich 2018). Additionally, the risk of lead exposure is not randomly distributed, but is linked to patterns of residential segregation in many areas that place people with particular characteristics, such as minority status or lower income, into older housing that is more likely to be connected to LSLs or contain internal lead plumbing (Sobsey 2006; Jacobs 2011). Overall, exposure to lead through drinking water has the potential to exacerbate existing racial/ethnic and SES health disparities as well as shape public debates about the importance of lead exposure through water, and what, if anything, should be done about it.

Because replacing lead-based water delivery systems is expensive and may take decades to achieve (Behm 2016a), some municipalities are promoting the adoption of lead-filtering POU systems through public programs that provide filters (Behm 2016b; Milwaukee Health Department n.d.) or through initiatives that educate the public about voluntary use of lead-filtering POU products. Given these initiatives and the millions of dollars spent or proposed to fund them (e.g., Spicuzza 2018), research that informs how and why people turn to POU systems is critically needed. Our study provides new information about the social and behavioral contexts that shape lead-filtering POU adoption and use among a sample of Americans.

Building on previous work that found race/ethnicity and SES influences perceptions of water quality among Americans (Pierce & Gonzalez 2016), our findings underscore that these characteristics influence patterns of lead-filtering POU adoption. This happens indirectly through disparate levels of self-reported exposure via LSLs, concerns about lead exposure through drinking water, and knowledge about the health effects of lead. Consistent with previous research about the concentration of racial/ethnic minorities and lower SES individuals in older housing (Jacobs 2011; Muller *et al.* 2018), we found that minorities and lower SES people were more likely to report living in a residence with an LSL or internal lead plumbing than White or higher-income individuals. We also found that reporting the presence of an LSL significantly increases the likelihood of also reporting lead-filtering POU adoption. Importantly, our study also revealed a public knowledge gap about residence water delivery. A majority of individuals reported not knowing if their residence was connected to an LSL (57%) or if their residence contained lead plumbing (50%). This matters because our regression analysis demonstrated that the presence of LSLs was an important factor associated with the adoption of lead-filtering POU systems that likely shapes perceptions about lead exposure risk. While our study design does not allow us to generalize these patterns to the U.S. population, they suggest that significant numbers of Americans may not be well educated about their possible exposure to lead through their municipality's water delivery system. Creating public information outlets that can be used to learn about the presence of LSLs or internal lead plumbing in residences and promoting their use in communities may be an important intervention point in policy-making on this issue.

Our data also indicated that measures that indicate a general sense of environmental risk around lead (concerns and knowledge about lead) are patterned by race, ethnicity, and SES, and that these attitudes and knowledge influence the likelihood of lead-filtering POU adoption. Racial and ethnic minorities and lower SES individuals exhibit higher levels of concern about lead exposure through drinking water than White individuals or higher SES groups. Given national reporting around the Flint water crisis that highlighted connections among drinking water and, especially, race (Eligon 2016; Almasy & Ly 2017), this may not be surprising. Importantly, we found that income conditioned levels of concern about lead in drinking water when it comes to the adoption of lead-filtering POU systems. Among lower-income individuals, it took higher levels of concern about lead exposure through drinking water before adopting lead-filtering POU systems. This connection between SES and adoption of a water safety strategy was consistent with limited previous research (Zheng & Flanagan 2017). Since lower-income individuals are at higher risk for elevated BLL in many communities, this finding highlights that health policy targeting lead exposure through drinking water by promoting lead-filtering POU systems may need to subsidize the initial and ongoing costs of filters. Furthermore, potentially nonlinear effects of income may need to be incorporated into cost-estimates of POU adoption strategies, such as those found in Verhougstraete *et al.* (2019).

In addition to concerns about lead in water, our analyses demonstrated that greater knowledge about the health effects of lead was positively associated with lead-filtering POU adoption, net of other influences. This statistically significant association in our multivariate analysis highlights the importance of promoting education on the health consequences of lead exposure if increasing lead-filtering POU adoption is an outcome that is desired in a particular community. Overall, our analysis suggests that social location (SES and ethnic identities) shapes individuals' sense of environmental risk, as well as the behaviors (such as adoption of a lead-filtering POU system) that flow from that risk assessment.

Our study also contributes to a limited knowledge base regarding the ways individuals think about and incorporate the use of POU systems into their daily practices. We found that lead-filtering POU adopters generally report high levels of confidence that they were using the POU filter system correctly. This group also reported generally high frequencies of using filtered water for drinking. Self-reported frequencies of use of filtered water for cooking were lower by comparison, and we found differences by ethnicity in that Hispanic individuals had a higher frequency of use of filtered water for cooking than NH respondents. Understanding the consistency with which individuals use water from POU systems is important because the occasional use of untreated water in cooking, for example, can contribute to continued exposure (Renner 2010) with negative implications for health. In general, this pattern of findings suggests that public education materials around lead education and POU use may need to emphasize the need to incorporate filtered water into more HH practices, like cooking.

Finally, our study provides information about why individuals that we think might want to adopt filters – those who report high levels of concern about lead in drinking water – do not. Both the initial and ongoing expense and the complexity of installing and maintaining POU systems were central reasons highlighted by respondents in this group. Lack of financial resources is a factor shaping health disparities more generally and appears to be important in the context of risk-mitigation strategies around drinking water (Zheng & Flanagan 2017). However, this finding also highlights the need to clearly understand the cost–benefit calculation made at the HH level, as well as the community or policy level (Verhougstraete *et al.* 2019) around POU use.

Overall, our investigation of the ways race, ethnicity, or SES may influence water concerns and behaviors was informed by sociological research that highlights how these group memberships shape unequal access to resources and different cultures of health that are linked to health disparities (Muller *et al.* 2018). In many communities, the day-to-day experiences around lead poisoning may sensitize particular racial, ethnic, and SES groups over others to this public problem. For example, in our community in Milwaukee, Wisconsin, racial, ethnic, and SES disparities in elevated BLLs among children are well known among the public, are linked to racial segregation in housing, and are sometimes a source of division in public health debates about what – if anything – should be done about lead exposure. This differing awareness about the causes and consequences of lead poisoning, which is often rooted in experiences that vary across racial, ethnic, and SES groups, can transfer into attitude differences about the importance of environmental health exposures. Understanding this patterning of experiences and attitudes may be important for engaging in debates about where public health efforts (and dollars) should be concentrated and invested.

Our findings should be considered in light of limitations imposed by the research design. Our MTurk sample is a U.S. convenience sample and may only be representative of participants who have access to human intelligence surveys. Even so, research indicates that MTurk samples are more representative of specified populations than other commonly used convenience sampling methods (Buhrmester *et al.* 2011; Levay *et al.* 2016; Sheehan 2017). While our MTurk findings do not provide population estimates, our results do identify key patterns associated with POU water filtration that can be used to inform future study of the motivations for lead-filtering POU adoption and the ongoing attitudes and behaviors that accompany adoption into homes.

Another limitation concerns our measurement. All of our survey measures are self-reported by our respondents. Thus, we cannot confirm that individuals that report living in a residence with an LSL, for example, actually do live in a home connected to an LSL. While many of our findings align in important ways with previous research (e.g., higher proportions of minorities report living in homes connected to LSLs), future work will need to further test the accuracy of self-reports such as these. However, we emphasize that in light of very limited information about the attitudes and behaviors of lead-filtering POU adopters, our study provides an important, albeit, exploratory first step in this direction.

Bench studies of POU filtration systems underscore their effectiveness in filtering lead from drinking water in laboratory settings (Brown *et al.* 2017), yet we know very little about the human and larger social elements that shape POU filter adoption and use. Indeed, Sobsey (2006: 20) argues: 'Almost completely lacking is a consideration of human behavior, attitudes, knowledge, and practices about drinking water and health'. This sentiment is echoed by Zheng & Flannagan (2017), who find that individual attitudes and beliefs that vary by SES significantly affect the adoption of healthy behaviors related to drinking water. This study responds to the call for further information about the human and social factors that shape drinking water behaviors with implications for health. A clear understanding of the social and behavioral context that influences the adoption of lead-filtering POU systems can inform policies aimed at improving public health in light of growing public awareness and concern about lead exposure through drinking water.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this paper is available online at https://dx.doi.org/10.2166/wh.2020.053.

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