



Barriers to Managing Private Wells and Septic Systems in Underserved Communities: Mental Models of Homeowner Decision Making

Abstract Some African-American communities in the U.S. South are excluded from nearby municipal water and sewer services and therefore rely on private wells and septic systems. These “underbounded” communities are disproportionately exposed to water contaminants and face elevated risks for poor health outcomes. Outreach efforts encouraging proper well testing and maintenance are needed to protect health in these communities. To identify knowledge gaps and misconceptions that such outreach programs should target, we conducted semistructured interviews with 18 residents of such communities in Wake County, North Carolina. Only one interviewee conducted annual well testing as recommended by the county health department. Interview results suggest that testing is inhibited by lack of awareness of well maintenance guidelines, overreliance on sensory information, poor understanding of exposure pathways, and cost. Links between private septic systems, well water contamination, and health are poorly understood, hindering proper septic maintenance. These findings highlight the need for risk communication materials targeting at-risk communities.

Introduction

Throughout the U.S. South, some African-American communities have been systematically excluded from municipalities through exclusionary zoning practices known as “underbounding” (Aiken, 1987; Lichter, Parisi, Grice, & Taquino, 2007). Today, municipalities control land use in these underbounded communities without providing services such as piped water, sewage disposal, and trash collection (Aiken, 1987; Lichter et

al., 2007). Underbounded African-American neighborhoods frequently rely on private wells and septic systems, although municipal water and sewer lines encircle or bisect these communities to reach majority White neighborhoods (Heaney et al., 2013; Johnson, Parnell, Joyner, Christman, & Marsh, 2004; MacDonald Gibson, DeFelice, Sebastian, & Leker, 2014). African-American communities excluded from municipal services are disproportionately exposed to water contaminants

Editor's Note: Supplemental figures were submitted along with this peer-reviewed article and have been posted online due to space limitations. The Journal did not copy edit these figures; the authors are providing them as extra resources should the reader want more information. The supplemental information can be accessed at www.neha.org/supplemental.

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and face increased health risks (Heaney et al., 2013; Stillo & MacDonald Gibson, 2017).

To minimize waterborne illness risk, households in underbounded areas should routinely test their water and take action when contaminants are detected (Centers for Disease Control and Prevention, 2014). Few private well owners, however, test their water as frequently as public health experts recommend (Schwartz et al., 1998). Although educational programs could promote well testing (Simpson, 2004), we are unaware of any research identifying what information and resources residents of underbounded communities need to improve stewardship of their water quality.

To identify homeowner perceptions, practices, and preferences related to private well and septic system maintenance and operation, we conducted semistructured interviews with residents in underbounded neighborhoods of Wake County, North Carolina. Our interviews followed the “mental models” framework, which involves assessing risk perceptions and behaviors and comparing them with expert recommendations to identify intervention needs (Bruine de Bruin & Bostrom, 2013; Morgan, Fischhoff, Bostrom, & Atman, 2002).

Here, we sought to inform outreach programs targeted at improving drink-

TABLE 1

Interview Questions

Introduction	Well maintenance
<ul style="list-style-type: none"> • What is it like to have well water? • Could you please describe how your well water works? • Do you have a septic system? If so, how does that work? • Tell me what you think about city water in comparison to well water. • What else can you tell me about well water? 	<ul style="list-style-type: none"> • Do you do anything to maintain your well?* Why (not)? • How often do you do maintenance work on your well?* • What do you normally do? • When was the last time you did maintenance work on your well?* • What did you do then? • What does it generally cost you to do maintenance on your well?*
Water quality perception	Septic maintenance
<ul style="list-style-type: none"> • How do you feel about the quality of your water? • How would you rate your well water quality on a scale from 0 to 10, with 0 being the worst and 10 being the best?* • Why did you give that rating? • How would you rate the city water quality on a scale from 0 to 10, with 0 being the worst and 10 being the best?* • Why did you give that rating? 	<ul style="list-style-type: none"> • Do you do anything to maintain your septic system?* Why (not)? • What do you do to maintain your septic system? • How often do you do maintenance on your septic system?* • When was the last time you did maintenance work on your septic system?* • What did you do then? • What does it generally cost you to do maintenance on your septic system?*
Water source preferences	Characteristics of well
<ul style="list-style-type: none"> • If you had a choice, would you like to have well water or city water?* Why? • Any other reasons? Can you explain (each reason)? • Do most of the people in this area also want (the preferred water)?* • If yes, why do they want (the preferred water)? • Does anybody want (the nonpreferred water)? Why (not)? • If no, why don't they want (the preferred water)? • Does anybody want (the preferred water)? Why? If preference is city water, what are some things that are keeping you from getting city water? If preference is not city water, what are some things that are keeping people who want city water from getting city water? 	<ul style="list-style-type: none"> • Do you know when your well was installed?* • How deep is your well?* • Is your well a hand-dug well, a bored well, or a drilled well?
Well testing	Pros and cons of water types
<ul style="list-style-type: none"> • Have you ever tested the water in your well?* • Why do you (not) test it? • How often do you test the water in your well?* • What kinds of tests do you do? • Where do you send your water samples for analysis? • When was the last time you tested the water in your well?* • What did the test results say? • Did anything change after you got the test results?* Why (not)? • Do your neighbors test their well water?* Why (not)? If yes, what do they do to test it? 	<ul style="list-style-type: none"> • Overall, have you enjoyed having well water?* • What are some good things about having well water? • What are some bad things about having well water? • What do you think are some good things about having city water? • What do you think are some bad things about having city water? • Do you know of anyone on city water who has noticed any unusual water tastes, colors, or smells?* If so, please explain. • Do you know of anyone on city water who has gotten sick from their water?* If yes, please explain. • Have you ever noticed any unusual tastes, colors, or smells with your water?* If yes, please explain. • Do you know of anyone else on well water who has experienced unusual tastes, colors, or smells with their water?* If yes, please explain. • Have you ever gotten sick from your water?* If yes, please explain. • Do you know of anyone else who has gotten sick from their well water?* If yes, please explain.
	Exit question
	<ul style="list-style-type: none"> • Is there anything else you did not have the chance to tell me?

Note. Questions were asked in the same order for each interviewee. Answers to questions marked by an asterisk are summarized in Table 3.

ing water quality in communities without access to municipal water services in North Carolina and elsewhere. Specifically, our research objectives were to 1) assess current well and septic system monitoring and maintenance behaviors in underbounded communities, 2) identify factors influencing these behaviors to guide future risk communication development, and 3) assess community preferences for private wells versus community water systems.

Methods

Participant Recruitment

Following approval by the University of North Carolina (UNC) Institutional Review Board, interviewees were recruited from 57 households participating in a previous UNC study of water quality in underbounded Wake County neighborhoods (Stillo & MacDonald Gibson, 2017). Recruitment letters were mailed to all 57 households offering

a \$50 gift card for participation. The first 20 respondents were enrolled. Two were excluded due to poor interview audio quality.

Interview Design

Interviews began with five open-ended questions about well water, septic systems, and city water (Table 1). Following the mental models approach, the script used neutral wording and avoided leading questions (Morgan et al., 2002). As the interviews progressed,

more focused questions were asked. Specifically, we focused on water quality perceptions, water source preferences, well testing, well maintenance, septic maintenance, well and septic system characteristics, and experiences with city and well water. To conclude, participants were invited to discuss any topics not previously covered.

Interview Coding

Each interview statement was coded to identify whether it addressed specific topics in expert models of private wells and septic systems. These models are represented as qualitative influence diagrams; they were created through a combination of literature review and expert consultations (see supplemental figures). Nodes in the expert diagrams represented critical factors influencing well and septic system management and performance. For example, private well diagram nodes included contamination sources (e.g., septic systems and groundwater contamination), well system components potentially affecting water quality (e.g., corrosion of plumbing), and specific contaminants that should be routinely monitored. Each node was assigned a code.

If an interview transcript statement referred to a node, it received the corresponding code. When most interviewees vaguely discussed a group of codes rather than mentioning each individually, multiple codes were merged into one new, more general code. For example, septic drain field parts received the same code because most interviewees did not discuss the drain field in detail. Another list of codes was added to represent topics commonly raised by interviewees but absent from expert models. For example, expert diagrams did not include cost, but all participants mentioned cost.

A team of coders was trained to apply codes to statements from three transcripts. Following training, the coding system was adjusted to improve accuracy. Subsequently, two coders independently coded each interview statement. Coders agreed on 55% of statements (Cohen’s $\kappa = 0.54$, excluding the three training transcripts). In cases of disagreement, a third coder decided between the first two codes. Finally, the number of interviewees mentioning each code was computed.

Results

To assess homeowner practices, perceptions, and preferences related to private well and

TABLE 2

Demographic Characteristics of Study Participants in Comparison With Participants of Prior Water Sampling Study and With Wake County

Characteristic	Study Participants	Original Cohort	Wake County ^c
Race/ethnicity (%)	Study Participants (n = 18) ^a	Original Cohort (n = 57) ^b	Wake County ^c
African-American	55.6	45.6	19.4
Asian	0	0	5.8
Hispanic	0	0	10.0
White	27.8	24.6	61.6
Other or preferred not to answer	16.7	29.8	3.2
Age (%)	Study Participants (n = 17) ^e	Original Cohort (n = 26) ^e	Wake County ^c
20–64	89.5	65.4	62.7
≥65	10.5	34.6	8.5
Income	Study Participants (n = 9) ^e	Original Cohort (n = 26) ^e	Wake County ^c
Median household income	\$62,500	\$40,000	\$63,791
Percent below the poverty line	11.1	19.2	11.6
Education (%)	Study Participants (n = 10) ^e	Original Cohort (n = 26) ^e	Wake County ^d
≥25 years with less than a high school diploma	10.0	3.8	8.1
≥25 years with a high school diploma or GED	0	23.1	16.8
≥25 years with some college but no degree	20.0	11.5	18.0
≥25 years with an associate degree	10.0	3.8	8.2
≥25 years with a 4-year degree	30.0	34.6	31.2
≥25 years with a graduate/professional degree or higher	30.0	23.1	17.7

^aParticipants in this study.

^bThe original cohort population is from Stillo & MacDonald Gibson (2017); 57 households participated in that study.

^c2012 U.S. Census.

^d2015 American Community Survey.

^eRefers to number of participants answering specific demographic questions.

septic system maintenance in underbounded communities and inform future outreach efforts, we conducted semistructured interviews with 18 homeowners, following the mental models approach (Morgan et al., 2002). We sought to determine whether participants followed recommended monitoring and maintenance practices, to identify key beliefs and factors that might influence adherence to these recommendations, and

to ask whether participants preferred private wells or would like to be connected to a nearby, regulated community water supply.

Characteristics of Study Participants

Table 2 compares our 18 participants with the 57 households in UNC’s water quality study of underbounded communities and with Wake County. The proportion of African-American participants (55.6%) was

TABLE 3

Summary of Responses to Direct Interview Questions

Interview Question	Statistic	Minimum	Maximum	<i>n</i>
Well characteristics				
Mean well age (year)	25 ± 13	1	50	17
Mean well depth (ft)	150 ± 88	30	290	10
Well type (N = 18)				
Dug	0%	–	–	
Bored	22%	–	–	
Drilled	44%	–	–	
Don't know	33%	–	–	
Well testing				
Has tested water	83%	–	–	19
Took action after testing	38%	–	–	13
Know neighbors who test water	12%	–	–	17
Frequency of well testing (year)	13 ± 14	1	~50	15
Well and septic maintenance				
Does anything to maintain well	44%	–	–	18
Does anything to maintain septic system	94%	–	–	16
Time since last well maintenance (year)	1.0 ± 1.4	<0.1	4.0	7
Time since last septic system maintenance (year)	3.4 ± 4.1	0.2	15.0	14
Well water quality perceptions				
Enjoys well water	89%	–	–	18
Has experienced unusual tastes, colors, or smells	22%	–	–	18
Knows others on well water who have noticed unusual tastes, colors, or smells	11%	–	–	18
Has been sick from own well water	0%	–	–	18
Knows others who have been sick from well water	5.6%	–	–	18
Water source preferences				
Well water rating (10 = best)	7.7 ± 2.0	2.5	10	18
City water rating (10 = best)	7.6 ± 1.7	5	10	16
Prefer well water to city water	72%	–	–	18
Anything preventing access to city water (% yes)	79%	–	–	14

slightly higher than for the 57 households in the UNC water quality study (45.6%) and much higher than in Wake County (19.4%). The proportion of participants over age 65 (10.5%) was lower than in UNC's water quality study (34.6%) but higher than in the county population (8.5%). Of interviewees choosing to report an education level (*n* = 10), 60% had a 4-year degree or higher, which was similar to the UNC water quality study (57.7%) and slightly higher than in the county's adult population (48.9%).

Testing and Maintenance Practices

One of 18 respondents tested their water annually as recommended by the Wake County Department of Health (Table 3, Figure 1, and see supplemental figures). Half of respondents reported testing less than every 5 years (*n* = 8) or never (*n* = 3). Additionally, eight respondents reported conducting well maintenance.

The North Carolina Division of Public Health recommends pumping septic systems every 3–5 years. Seven respondents, however, either were unable to recall their last septic

system maintenance or reported last pumping more than 5 years ago. One respondent last pumped their system 15 years ago.

Although all 18 interviewees mentioned water testing, few knew what to test for or how often. For example, six respondents mentioned the need to test for bacteria, but only three were aware that health departments recommend annual bacterial testing. Only three mentioned needing to test for pH and total dissolved solids, and none mentioned pesticide testing. All but three homeowners were unaware that testing should be routine, rather than conducted only once. For example, after describing a previous bacterial contamination event, one participant said, "Oh, I haven't had it tested since that incident....Should I have had it tested again?"

To better understand testing barriers, we asked interviewees why they do not test their water. Answers included "I never thought of it, never thought it needed testing" and "I don't really know what all [testing] entails.... I don't know how to get it tested." One homeowner, although knowledgeable about well systems and contamination sources, justified not testing with "just hadn't gotten around to it." These statements indicate low awareness of testing procedures and their importance in ensuring safe drinking water.

Participants seemed unaware of the need to inspect their well each year or to conduct other routine maintenance activities (see supplemental figures). Only one interviewee mentioned having an annual well inspection. Three people mentioned inspecting wells to protect water sources and two others mentioned inspection by a licensed contractor, but these interviewees thought inspections were needed only upon home purchase. Additionally, 17 participants commented on issues related to well maintenance.

One interviewee described regularly shock chlorinating the well as "anything to do with a home or that comes attached to the home, you have to do maintenance on it and you have to keep it up, so when I first bought the house, I was kind of given just verbal instructions on how to maintain the well, how to keep it clean...every so often you have to shock [chlorinate] the water maybe about once a year and several things like that."

Nonetheless, of these 17 respondents, only one was aware of routine maintenance needs.

One homeowner stated, “I didn’t realize that other than testing periodically that there were things that I could do [to maintain my well] because it’s a covered well.” Other participants described avoiding upkeep unless their well breaks or water quality becomes poor: “I don’t do anything to maintain it.... It’s just wait until something happens.”

Of the 17 participants with a septic system, 16 conduct routine maintenance. Two people discussed inspecting septic systems and 13 mentioned septic system pumping (see Figure 2, supplemental figures), although as previously noted, only 11 participants followed the recommended pumping frequency (every 3–5 years or more often if the solids level surpasses one third of tank capacity). Misconceptions about pumping frequency were common. For example, whereas experts recommend pumping septic tanks when one-third full with solids, one homeowner said, “You know, once [the septic tank] gets full, you have to have them...clean it out.” Another participant said, “I know if we ever get a bad odor, then we have to have [the septic tank] cleaned out.... I know it’s been about 15 years [since I last had the septic tank pumped].” Thus, although pumping was frequently mentioned, some homeowners still lacked knowledge about its importance or recommended frequency.

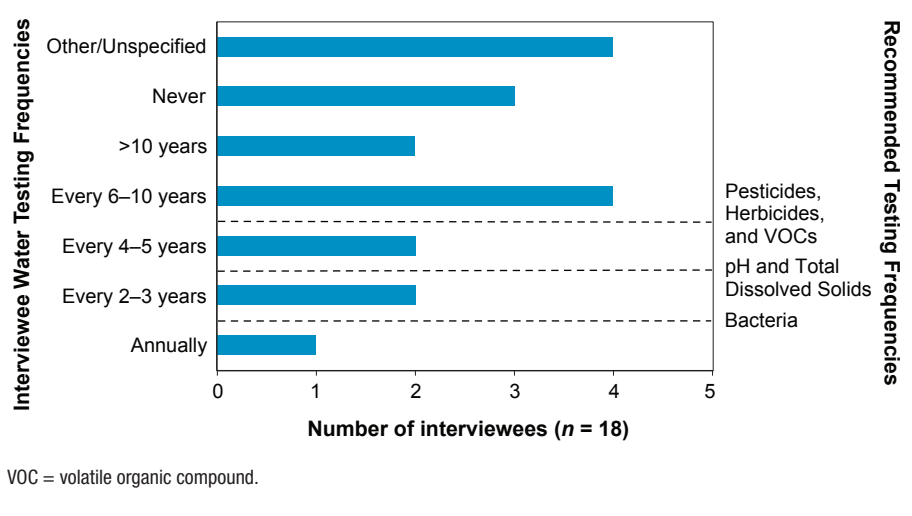
Most or all participants overlooked several other factors identified by experts as affecting septic system performance. For example, none mentioned that flushing large water or waste quantities at once overloads the system and reduces functionality. Although one interviewee mentioned flushing chemical additives, no one correctly discussed how certain chemicals, solids, or cooking oils can harm the system. Only six participants recognized the need to avoid septic system additives. Only four realized that vegetation other than grass should not be planted in the septic drain field. These findings suggest that homeowners are generally unaware of how to ensure septic system functionality.

Beliefs Influencing Well and Septic System Stewardship

In addition to low awareness of expert monitoring and maintenance recommendations, our interviews revealed three belief categories affecting well and septic system stewardship: 1) inaccurate beliefs that all water contaminants can be detected through sensory perception, 2)

FIGURE 1

Private Well Owners Self-Reported Water Testing Frequencies as Compared With Frequencies Recommended by the Wake County Department of Environmental Services



low awareness of septic systems as a water contamination source, and 3) poor understanding of contaminant exposure routes.

Assessing Water Quality With Sensory Information

All 18 interviewees mentioned reliance on appearance, smell, and taste to detect contamination. As one homeowner put it, “I don’t know, [about my water quality] because I haven’t had results from the tests, but right now I feel like [my water quality] is fine as far as the human eye can see and the nose can smell and my hands can feel. Those are the only things I have, my senses.”

Another homeowner said, “I think water should be clear as water should be and if it’s anything other than that, I wouldn’t want to cook or drink with it.” Many participants conveyed that sensory information prompts testing practices and remedial actions. One such interviewee stated “Basically, when we first moved in [we tested the water] because our water tasted funny.” The majority of interviewees (14) reported not having noticed unusual tastes, colors, or smells in their water.

Links Between Septic Systems, Well Contamination, and Health

Only one interviewee mentioned septic waste as a well water contamination source and

none mentioned failing septic systems as a waterborne disease source. These results indicate that homeowners do not realize important links between functioning septic systems, good water quality, and health.

Poor Understanding of Exposure Routes

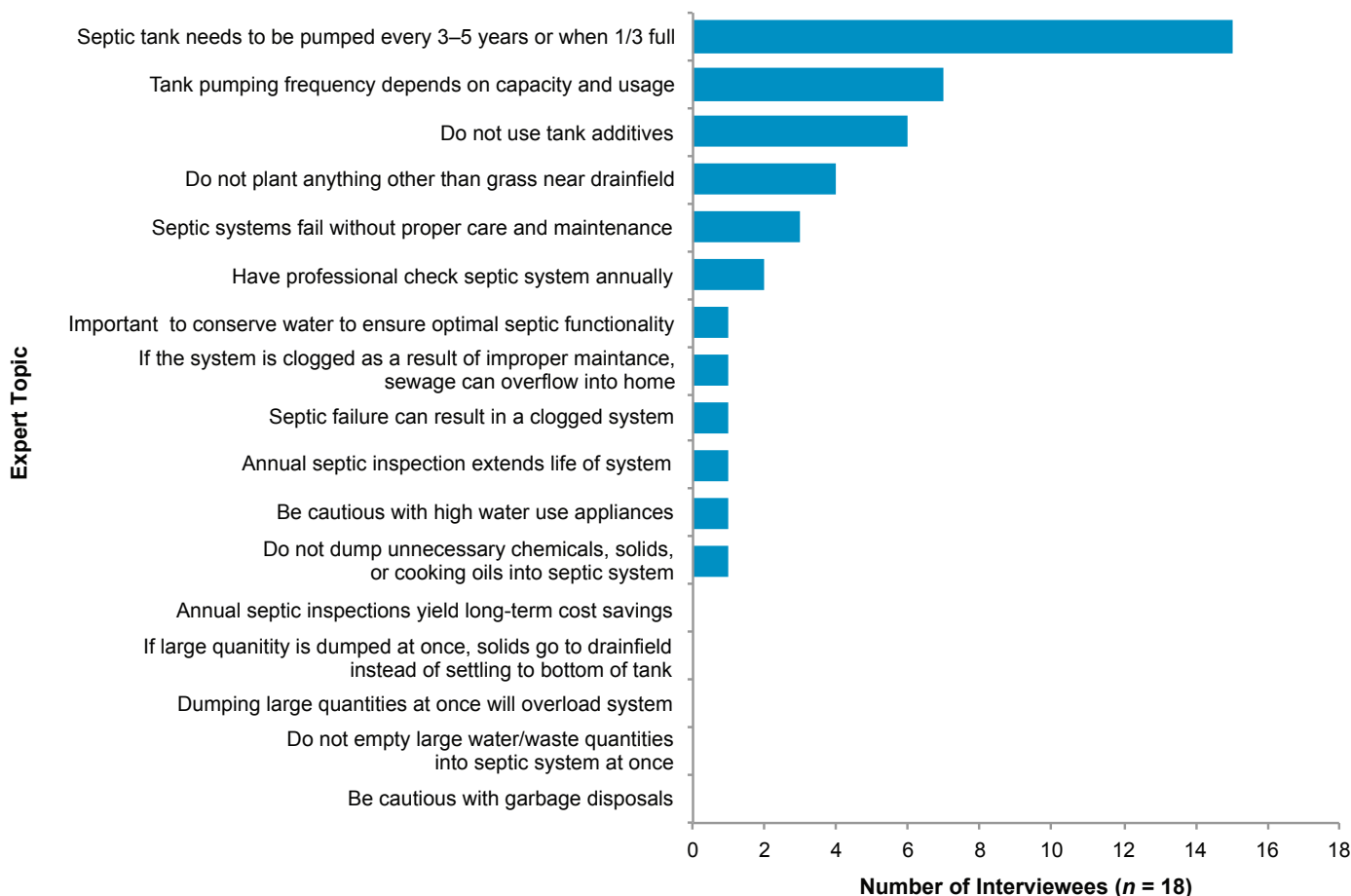
One person mentioned inhalation and three mentioned dermal contact as waterborne contaminant exposure routes. Five respondents mentioned that they avoided drinking their water because of its poor quality, yet they still used it to bathe and wash clothes or dishes. Three interviewees saw avoiding water ingestion as a rationale for forgoing testing. When asked why they did not test their water, one person responded, “Because we don’t drink it.” Thus, homeowners seem unaware of health effects from exposure via dermal contact and inhalation.

Private Well Versus Community Water Preferences

Overall, 16 respondents reported enjoying well water (Table 3). They generally rated the quality of their well water as similar to that of city water (7.7 ± 2.0 versus 7.6 ± 1.7 on a 10-point scale). Among respondents, 14 preferred well to city water; however, 14 mentioned barriers “that are keeping people who want city water from getting city water.”

FIGURE 2

Frequency With Which Interviewees Mentioned Key Factors Related to Private Septic System Maintenance as Recommended by Experts



Although not included in the expert models, all interviewees mentioned cost (see supplemental figures). Seven homeowners said they do not have to pay for well water and 13 specified not having monthly water bills. Seven elaborated upon well costs in comparison to city service costs: “I [do not] need a water bill....I [do not] have additional taxes to cover the cost of the water service....One of the downsides of well water is that you have to incur [maintenance] costs, and so there’s risk if the pump fails or other parts fail.”

Three interviewees expressed cost as a barrier to achieving better water quality. One stated that “cost and the issues about doing [testing] properly [are keeping me from testing more frequently].” Another explained

that “the filter system...is very costly, so we just weren’t in a position to purchase it.”

Control over water quality, also not included in the expert models, was discussed in 10 interviews. Three interviewees described feeling more in control with private well water than city water. As one put it, “I like having more control over the quality of my water...I feel safer actually...You have more control over the quality of the [well] water...Having very little control over what is in the [city] water is the biggest thing, and very little knowledge of what’s in it.”

Another interviewee said, “I basically know what I’m drinking since I’m responsible for [my well water].” A third explained, “A terrorist attack on a municipal water system. That seems kind of scary....Also we have a

very enclosed water system...we’re not at the mercy of everyone else.” Related to these comments was the perception that well water is more “natural” than city water due to the lack of chemical additives. These observations indicate that homeowner mental models emphasize being in control of water quality.

Fourteen participants mentioned water availability. Nine said that relying on wells instead of city systems provides freedom to use unlimited water. One interviewee stated, “I can use [my well] as I see fit....[My water is] not regulated by somebody telling me you can’t use any water for this or you can’t use any water for that the way they do.” Conversely, three described having insufficient well water. One interviewee explained that “When I do laundry....I notice that the well

tank, the pump will shut down...either it overheats or there's not enough water in the well because I'm using so much." Another participant said, "I would rather have [my well] water...add more convenience to my lifestyle....I would love to have [my well water] more accessible." These statements signal that homeowners value convenient access to an adequate water quantity.

Discussion

We sought to assess whether residents of underbounded neighborhoods of Wake County, North Carolina, follow expert recommendations for maintaining their wells and septic systems. We also sought to identify beliefs influencing maintenance practices and to determine preferences for private well water or municipal water service. Our results suggest that residents of these neighborhoods do not adequately test or maintain wells and septic systems. Nor are they aware of any guidelines. The perception that testing is unnecessary if water looks, tastes, and smells clean was common.

Only one respondent was aware of the need for annual well inspections. Similarly, only one respondent recognized the effects of septic system maintenance on well water quality. Some respondents—unaware of dermal and inhalation exposure routes—indicated they do not test their water because they use it only for bathing and cooking. Many respondents said that cost was a barrier to ensuring good well water quality. Cost also influenced preferences for well water over municipal water, which would require monthly utility bills. Despite not following well monitoring and maintenance guidelines, many respondents believed that they had more control over their water quality than would be possible with municipal water.

Although our study was the first to assess well and septic system maintenance in marginalized African-American communities, the low frequency of private well testing among our interviewees echoes recent findings in North American rural areas (Borsuk, Rardin, Paul, & Hampton, 2014; Jones et al., 2005; Swistock, Clemens, Sharpe, & Rummel, 2013). For example, a survey of 701 rural well owners in Pennsylvania found "Zero to 31% of homeowners with water supplies that contained unsafe levels of bacteria, nitrate-N, arsenic, or lead were already aware of these water quality problems" (Swistock et al., 2013).

Similar to what we found in our study, focus groups with private well owners in rural New Hampshire found that few were informed about local, state, and federal testing guidelines (Borsuk et al., 2014). Additionally, the misperception that testing is only necessary if the water tastes, looks, or smells contaminated has previously been reported among private well owners in New Hampshire and Ontario (Borsuk et al., 2014; Jones et al., 2005). The New Hampshire study indicated that among well owners who do not test their water, 20% reported cost as a barrier (Borsuk et al., 2014).

Our findings of low awareness of connections between septic system maintenance and well water quality, along with misperceptions about septic maintenance guidelines, are also consistent with prior studies. For example, our prior interviews with North Carolina city officials in charge of evaluating whether to extend municipal services to underbounded areas found that most were unaware of the effects of septic tank failure on water quality and health (Naman & MacDonald Gibson, 2015). A study in rural New York found that more than one third of septic systems had never been pumped (Schwartz et al., 1998).

This study was designed to use semistructured interviews to elicit beliefs, rather than to administer a large survey that presupposes what those beliefs are. Due to the small sample size, our results cannot be used to determine belief prevalence. Instead, our findings highlight *which* beliefs people may hold, not *how common* those beliefs are (Bruine de Bruin & Bostrom, 2013). Prior analyses of interview findings support that a sample size of 10–15 generally is adequate for identifying the most commonly held beliefs in a population (Bruine de Bruin & Bostrom, 2013; Morgan et al., 2002).

Yet, one limitation is potential bias introduced by enrollment methods. Participants previously volunteered for water testing as part of a related research project (Stillo & MacDonald Gibson, 2017). Additionally, we enrolled the first 20 people who responded to our recruitment letter. Our enrollment methods could have included participants who are more proactive than the general population. Furthermore, it is also possible that enrolled subjects experience more water quality problems, potentially from a lack of well and septic management, and therefore were prompted to act.

Conclusion

Our study reveals key factors influencing testing and maintenance of private wells and septic systems in majority African-American neighborhoods that are underbounded, or excluded from nearby municipal water and sewer service. Key factors include lack of knowledge of health department water testing guidelines, beliefs that contaminants can be detected through sensory perception and that testing is unnecessary when drinking bottled water (even when using well water for cooking and bathing), the presumption that well water is of high quality (even if never tested), lack of understanding of contamination sources, and cost.

To design effective risk intervention programs to improve water quality in underbounded communities, a large-scale survey measuring belief prevalence in the target population is needed (Bruine de Bruin & Bostrom, 2013). Subsequent risk communications can be designed to correct common misconceptions about the importance of testing and maintaining private wells and septic systems (Morgan et al., 2002). Additionally, due to emphasis on costs throughout these interviews, subsequent research should assess the degree to which removing cost barriers would influence water system stewardship and preferences. 🐼

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JEH Quiz #1 Answers July/August 2018

- | | | | |
|------|------|------|-------|
| 1. c | 4. a | 7. b | 10. b |
| 2. b | 5. c | 8. c | 11. a |
| 3. d | 6. d | 9. b | 12. c |

→ Quiz deadline: March 1, 2019

1. Research objectives were to
 - a. assess community preferences for private wells versus community water systems.
 - b. identify factors influencing behaviors to guide future risk communication development.
 - c. assess current well and septic system monitoring and maintenance behaviors.
 - d. all the above.
2. Interviewees were recruited from 57 households that participated in a previous University of North Carolina study of water quality in underbounded Wake County neighborhoods.
 - a. True.
 - b. False.
3. Overall, semistructured interviews were conducted with ___ homeowners.
 - a. 57
 - b. 20
 - c. 18
 - d. 16
4. Of the study participants, ___ were African-American and ___ were White.
 - a. 55.6%; 27.8%
 - b. 45.6%; 24.6%
 - c. 27.8%; 55.6%
 - d. 19.4%; 61.6%
5. Of the study participants, ___ reported an education level of a 4-year degree or higher.
 - a. 10%
 - b. 20%
 - c. 30%
 - d. 60%
6. The North Carolina Division of Public Health recommends pumping septic systems every
 - a. six months.
 - b. 1–2 years.
 - c. 3–5 years.
 - d. 6–8 years.
7. ___ study participants either were unable to recall their last septic system maintenance or reported last pumping more than 5 years ago.
 - a. Six
 - b. Seven
 - c. Eight
 - d. Nine
8. Of the study participants, ___ tested their water annually as recommended by the Wake County Department of Health.
 - a. 1
 - b. 4
 - c. 6
 - d. 9
9. Reliance on appearance, smell, and taste to detect contamination of well water was mentioned by ___ of the study participants.
 - a. 25%
 - b. 50%
 - c. 75%
 - d. 100%
10. Overall, ___ study respondents reported enjoying well water.
 - a. 10
 - b. 14
 - c. 16
 - d. 18
11. The study interviews revealed the following belief category(s):
 - a. poor understanding of contaminant exposure routes.
 - b. inaccurate beliefs that all water contaminants can be detected through sensory perception.
 - c. low awareness of septic systems as a water contamination source.
 - d. all the above.
12. Due to the small sample size, the findings highlight which beliefs people may hold, not how common those beliefs are.
 - a. True.
 - b. False.

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