# COMMUNITY-BASED RESEARCH METHODS TO INFORM PUBLIC HEALTH PRACTICE AND POLICY: THE CASE OF LEAD IN THE MISSISSIPPI DELTA


by

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A thesis submitted to the faculty of The University of Mississippi in partial fulfillment of the requirements of the Sally McDonnell Barksdale Honors College

Oxford

December 2018

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## ABSTRACT

Environmental health issues are complex and require interdisciplinary and community engagement approaches to better understand them and inform policy. As one example, lead exposure has a number of dangerous neurological effects, including developmental delays and learning deficits. Potential lead exposure through drinking water and paint are areas of concern. In a 2018 document, the Environmental Protection Agency (EPA) estimated that up to 20% of lead exposure comes from drinking water alone. By using a type of engagement research called community-based research (CBR), this project began to address this major public health issue. CBR can be used to connect residents, their local organizations, and researchers to address a public health issue such as lead exposure. This project implemented and evaluated methods of outreach, research, and education to monitor and reduce lead exposure in drinking water. Operating primarily within the Mississippi Delta, partners worked with community organizational leaders to engage their constituencies around lead. These partners helped to foster an environment of learning and inclusion that gives community members the opportunity to engage a problem themselves. The team conducted several community outreach events in different areas of the Delta where participants could learn about the dangers of lead and have their water tested for lead content. Each workshop employed common CBR strategies, yet each followed a somewhat different structure. The effectiveness of these methods was evaluated using both quantitative and qualitative analysis. We found that some methods were more effective in terms of self-reflected community engagement, bottle return rates, and cost effectiveness. The results of these analyses allowed us to make recommendations for improved outreach and engagement as well as the use of these approaches for more effective environmental health policies.

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## Introduction

According to the American Public Health Association, public health "promotes and protects the health of people and the communities where they live, learn, work, and play" (2018). It is an ever-growing field that seeks to incorporate the health of the public as a collective, not just the individual, into everyday life. Public health is studied throughout the United States in many ways, such as in college classrooms, in medical schools, in graduate programs, as well as in communities outside of an academic setting. One such type of study is called community-engaged research or community-based research (CBR). CBR is a practice of collaboration between researchers and community members, beginning with a topic of importance to the community that aims to use research to inform social change (Weisman, 2012). Collaboration between university researchers and community members allows research to expand further than traditional studies. By incorporating community members as partners, CBR opens participants to new ideas and perspectives which traditional research approaches might not necessarily encounter. There are many different types of this research, including community-based participatory research, action research, citizen science, and many more (Stoecker, 2005), which all allow for participation by different community members in the research. By involving the members of the community as partners, rather than simply as subjects, CBR allows members of a particular community to participate in a way that gives them ownership and some control in the project. Participants are provided opportunities to invest in, rather than observe, research in action. If community members are actively engaged, included, and collaborated with, the research can not only serve to benefit the university and its constituents that are traditionally doing the research, but it can also serve to empower the most marginalized members of a specific community by amplifying their voices to be heard. By creating an atmosphere of inclusion, ownership, and partnership, the line between researcher and community becomes blurred, allowing for some of the divisions between academics and non-academics to be removed (Hacker, 2013). Community-based research uses community-researcher collaboration as a catalyst for change within a specific community, using relationships to establish trust and perform effective research to inform future projects, programs, or initiatives.

**Types of Community-Engaged Research**

There are several different strategies for engaging the community, each with characteristics specific to itself, while each also has common tenets shared with other types of engagement research. It should be discussed beforehand and then in an ongoing manner the level of participation that is warranted from each party. These varying degrees of participation can be distinguished based on the type of research. The first of these types is known as citizen science. Citizen science is a practice of scientific research that is done by the public, typically in collaboration with professional scientists or scientific institutions (Citizen Science Association, 2018). This type of research allows for education in scientific research as well as involvement and engagement of community members. Community-based research, as defined above, is also a type of community-engaging research. With community-based research, participants are asked to engage in the project, more so than they would in traditional research, encouraging ownership and investment in the project (Halseth, Markey, Ryser, & Manson, 2016). Community-based research expands deeper into communities than does traditional research, allowing members and stakeholders to become engaged and active participants of the research. Another type is community-based participatory research. According to Karen Hacker, “The community-based participatory research approach encourages engagement and full participation of community members in every aspect of the research process from question identification to analysis and dissemination (Hacker, 2013, p. 2). This type of research, while still employing many common methods associated with other community-engaged research methods, is highly dependent on the full participation and investment of stakeholders. In this type of research, the line between researcher and participant becomes increasingly blurred as each person involved takes on similar roles in the project. Another important type of research is community-based participatory action research. This model is very similar to community-based participatory research in that it is dependent on the full engagement and investment of stakeholders, while using the community as a basis for that involvement. The two are different primarily in the end goal that this research is typically geared toward improving the action taken by the community toward transformation and social change (Burns, Cooke, & Schweilder, 2011). This research allows for the community participants not only to become involved in the research, but also to learn to influence change in their communities and continue the researchers as more than participants, but also as stakeholders. Taken together, every type of community-based research can be used to inform a broader concept of community engagement in research.

Each of these types of research shares common themes, ones upon which a foundation of engaging research can be built and continued. These themes include developing a conceptual knowledge of community problems in order to address them, learning to define communities based on the intersections of place and identity and how those two intersect, as well as partnership between community members, academic researchers, and their respective organizations. These types of research also include trust built by forming long-term, impactful relationships, the use of multiple methods of engagement and outreach through as many venues as possible, and the engagement of stakeholders and participants as contributors to the research (Halseth et al., 2016; Hacker, 2013). The term "community-based research" will be used throughout this document. However, it is important to note that this project was not narrowed specifically to one type of research, but sought to encompass the broader, more similar tenants of community-engagement, partnership, and ownership of the project with communities, individuals, researchers, and community partners, along with recognition that this is an evolving process.

**Identifying the Community**

A key factor in successful community-based research is properly identifying the community. An early challenge identified in many CBR projects is defining the "boundaries" for the community. These boundaries are not merely geographical, but they are also demographic, social, cultural, psychological, and collective boundaries. In some circumstances, it is highly beneficial to focus not just on one characteristic of a community, but the intersection of several characteristics that unify a group (Halseth et al., 2016). These issues can range from environmental health to economic development to youth outreach programs. By identifying community and defining the boundaries that tie them together, the problems that are at the forefront of that community can be identified by those who are most affected by them. In order to do research, there must be a question asked. To conduct community-based research, there is no better place to find that question than in the community itself. Many times, research questions are defined and set by the researchers and those who participate have little to no control over the research. With CBR, the community and its participants are just as much in control as the researchers from outside the community. In order to properly conduct CBR, decisions should be made by not just the professors or students, but the community members who themselves, many of whom will become researchers (Halseth, 2016; Stoecker, 2005; Jones, Koegel, & Wells, 2010; Albah, Carroll, Bronleewe, 2016; Andrews, Newman, Cox, Bunting, Meadows, 2012). This gives the community members the opportunity to affect change in the areas that they, as representatives of that community, deem important. Through this approach, research questions can be asked that would be beneficial for both community members and researchers.

Community participation is critical when conducting this type of research. CBR is not a traditional research framework—one in which researchers ask a question and test it how they see fit. Within the framework of CBR, community members are partners in the research, although types of levels of participation may vary. There is a shared ownership and an expectation that there will be benefits for all parties involved (Halseth et al., 2016). This ownership allows community members to feel that they are stakeholders in the research, giving them the initiative to shape it in the best way they see fit. This, combined with university or institutional researcher involvement, allows the project to be shaped in order to fit both the community and the researchers' needs and interests.

**Identifying Community Participants**

Another difficult but important aspect of CBR is finding the members of the community that will co-facilitate the research. Whether all members of the community will be treated as equal partners and the research will be open to everyone or whether there will be a group of people who will act as representatives for the community should be decided beforehand. Before any research can take place, it is crucial that roles of participants and collaborators are decided by all partners involved. This sets guidelines for the participation level and collaboration that will take place throughout. In traditional research on a particular group, the members of that group who participate are typically viewed as subjects or merely contributors. With community-based research, however, these people are asked to participate as partners and co-facilitators (Halseth et, al. 2016). As co-facilitators, community members can have valuable input in designing the research and methods that will be used. Although each has defined responsibilities, these roles also tend to develop organically over time. This permits the extension into the community in a way to the community typical research would not allow.

**Relationship Building**

One of the more difficult aspects of community-based research is the relationship building that it requires. In order to conduct research that involves community members, there is a certain level of trust that is required in any community. Many times, in CBR, researchers are approached by community members and asked for help to conduct research with them. This implies there has already been a foundation set for research to be done alongside concerned or interested community members, making the process of beginning research much simpler. For those who have not already established a relationship, the process can be much more difficult. In some communities, researchers are seen as distrustful and exploitative, only using these communities that face challenges as a means to further their own careers or research (Stoecker, 2005). Because of this history of distrust, communities may be reluctant to permit research to take place. To overcome this divide, professional researchers (professors, research staff, and students) must work to build relationships that create validity for their work as well as legitimacy within the community. These relationships, which often times require a personal connection, take time and effort to forge, much like research itself. In order to create these relationships, researchers must consider several factors that, if handled correctly, can serve to benefit the research. Much like any community project, the researchers must spend time getting to know the community with which they will work. While spending time in these communities, researchers must also identify community leaders who could have an impact on the project. These leaders can help to build new relationships and expand community partnerships (Stoecker, 2005; Holland, 2013). The development of relationships with established community partners can help to get research off the ground and begin projects that would benefit all parties involved sooner and with more trust among the members of the community.

Another important detail that is often forgotten by many researchers is neutrality. "Neutrality and consistency of approach in the research process are critical at this stage…Mapping power dynamics and informing different factions of the community about the intentions of the research will help to construct a more balanced research design and a more robust long-term set of research relationships" (Halseth et al., 2016, p. 73). By determining power dynamics and community roles, researchers will understand where the key players are in the community and how they can be engaged to foster an environment of trust and collaboration. These community leaders are those that will represent the community in the research and advocate for the project at hand. Some researchers choose their leaders based on their previous and current leadership and community involvement (Albah et al., 2016). If representatives for the research are chosen from community leaders, then the crucial step of relationship building has a previously built foundation of trust with other members of the community.

When building relationships, it is important to be aware of community partners or groups that are already helping to build the community. Within most communities, there are organizations or foundations that have already inserted themselves into the community in hopes of creating social change. While many of these organizations are small in scale, they are still crucial in building community partnerships. For example, in a study on the effectiveness of community-based participatory research (CBPR), researchers from Charleston, South Carolina conducted a study on the key indicators for successful CBPR.

The authors claim that while community partners may not have the finances available that universities or other large academic organizations have, they can still provide crucial information about the community, as well as other necessary resources (Andrews et al., 2012). These partners already have built a foundation within the community that allows them to expand and do outreach that new, less established researchers many not be able to conduct. While the partners might be youth outreach groups, local government, or any small grassroots movement, they may already have access to other community resources to which researchers may not yet have access.

**Building Community Capacity for Participation and Social Change**

Although determining who will participate and the structure of the research is very important, one frequently overlooked aspect of the research is community capacity. Many times, the methodology and technical components of the research from the community can be completely planned out, but the community is unable to fulfill the requirements set for them or they are not able to commit fully to the project due to other responsibilities, or a host of other issues (Halseth et al, 2016; Stoecker, 2013; Jones, Koegel, & Wells, 2010; Hacker, 2013). Because of these issues, it can be difficult to conduct community-based research in an effective, yet participatory manner. In order to understand and potentially build community capacity, researchers must be open and explicit about the research process and what it entails with those participating. It is very important that all project collaborators are on the same page and understand the details of the research project. Researchers who are accustomed to typical researcher-participant dynamics may have difficulties not being an equal partner in the research. These researchers may create a considerable power dynamic that can hinder the research project. This power dynamic can lead researchers to shape the project entirely, leaving the participants to be nothing more than just that—participants. It is important, however, to keep in mind that for CBR to function properly, researchers must facilitate an environment that allows the community members to also act in a position of control. By giving them the authority to help shape the research, community members are likely to feel they have ownership over the research and keep them invested. Another way to minimize the power dynamic between each party is for researchers and community members alike to assess the existing policies, institutions, and funding that govern the project (Halseth et al., 2016). This assessment and subsequent discussion can lead to an understanding among all parties about the expectations of each participant. Many times, researchers forget that they are co-collaborators on research and that they are not playing the traditional role of research.

**Methods and Approaches**

As with any research project, research design and methods are critical components to of community-based research. It is important to determine how the research will be conducted, and with CBR this must include the ways in which community members will be engaged and involved. There are a number of different types of community-based research, each differing in levels of community involvement. Each of them is very similar in their structure and methodology, however.

When structuring the research, there are a few key steps that will aid in the process: 1) choosing a research question that will generate good data, 2) designing the research methods for effective CBR, 3) collecting the data generated by the question and research methods, 4) analyzing the data in the context of that community, and 5) reporting the data and implementing projects that may aid the community (Halseth et al., 2016).

In the first step, choosing the research question, it is important to determine a question that is flexible, but not so much as to undermine the structure of the research. Asking a question that is too broad can generate answers that are much too broad and cannot support CBR or action (Halseth et al., 2016). These questions, such as "What is wrong with our community?", can lead to a wide variety of answers, none of which create common ground or a specific area to focus on. Other questions can be too narrow or specific. By asking questions such as "How can we use a youth outreach program to improve our schools?" implies that only a youth-outreach program will be able to improve schools, thereby narrowing the question to a degree that communities have no way to answer it other than by varying degrees of youth outreach programs (Stoecker, 2005). Because determining the question should, at least in part, be community driven, the question must be focused on an issue or concern that community members have. Researchers may guide those community members to narrow their question to be more specific but must be very careful not to show bias or force the community members in one direction or the other. With a good question to research, community members and researchers can generate data that, if utilized properly, can affect community change.

In the second step, designing the research and planning methods, collaborators must decide on a style of research that can effectively generate data and answer the research question. It is important to consult all collaborators throughout the process, but especially during the research methods determining process. There are several different ways to perform research—surveys, interviews, focus groups, workshops, outreach programs, school programs, etc.—but the most important aspect is to collaborate with community members so as to keep the research project within the context of that community (Stoecker, 2005). By designing the research methods together, all of the details can be discussed with all participants and there can be a clear definition of roles of each participant and collaborator. It is important to consider the ideas and experiences of community members in research methods because those methods are the ones that will lead to generating usable data.

The third step, collecting data, is dependent on the research design and methods. With an effective research design, data generated can be extremely useful in effecting community change. As previously mentioned, there are innumerable ways to collect data. All of these methods allow data collection that can later be analyzed for project or program implementation. An often-overlooked aspect of data collection concerns the limited resources available to many community members and researchers. By asking those community partners involved in the research to collect data that are not readily available to them, it can cause tension because of the extra workload that this project may put on them (Stoecker, 2005). It is important to be aware of the barriers to data collection that are in place for both community members and researchers before beginning an in-depth project. For example, many places have restrictions on different data, such as crime rates and health records. It is important to discuss these barriers with all collaborators before beginning the research.

Analyzing data, the fourth step, allows the researchers to develop conclusions from the research. This is where the data collected can be used to plan for future project or program implementation. By analyzing the data, researchers can answer the question that was originally set at the beginning of the research process. An important step in CBR is allowing the community collaborators to also participate in data analysis. This participation effort involves training community members in how to analyze the gathered research. One of the benefits of training some participants in analyzing data is the empowerment of those community members to do their own research and analyze their own data (Halseth, 2016; Hacker 2013). Training them to do their own data analysis provides them the tools to continue the research project into the future or design their own potential research projects. This is also an important aspect of building community capacity for research and action. The inclusion and training of community members as equal partners in the research fosters the spirit of CBR.

The final step, presenting the data, is an imperative step in the research process. Research, particularly community-based research, is useless if it serves no purpose for the community. Involving the community and all partners is an integrative part of CBR, so presenting the data in a useable and accessible manner helps to establish inclusion within the research process (Stoecker, 2005). If the data are accessible to community members and research partners, then collaborators have the ability to use that data to plan projects or programs that will strive to improve the community. This presentation of data will also help to open the discussion for improvements to the research design for future projects.

**Conclusion**

Community-based research, if done effectively, can have a lasting impact on the communities in which it is practiced. By showing community members that they are just as important in the research, the most marginalized groups can feel empowered to do their own research and make a difference within their community. Unlike traditional research, CBR allows researchers and community members to establish a relationship as co-facilitators and collaborators. These relationships, which are built on a foundation of trust and co-leadership, create a network of ties within communities that will continue to expand and create a legacy of helpfulness and legitimacy within the community. By staying involved as a community partner—rather than as a researcher who leaves when the research is done—researchers can create partnerships that will grow and create a lasting impact.

One substantive issue that CBR may inform is exposure to lead, a major public health concern. This is the topic addressed in the next chapter.

## ELEMENTAL LEAD EXPOSURE

### Introduction

Lead is a neurotoxin and can cause several detrimental health problems, including attention-deficit disorders, learning disabilities, stunted growth, mental disabilities, seizures, coma, or even death if encountered at high concentrations (Bellinger, 2008). Not only do these issues pose immediate medical problems, but they have lasting effects on physical and cognitive development. An obstacle to proper cognitive development can change a child's ability to develop social skills as well as proper psychological function in society. According to the Centers for Disease Control and Prevention (CDC), at least four million households in the United States have children that are exposed to high lead levels. Of these households, nearly half a million children under the age of five have blood lead levels (BLLs) greater than 5 micrograms/deciliter (μg/dL), the level at which the CDC recommends action be taken to improve these conditions (Centers for Disease Control and Prevention, 2018). The physiological risks for lead exposure pose serious threats to all those exposed. Those who suffer the most severely from the effects of lead, however, are young children and pregnant or nursing mothers. According to the CDC, pregnant women are at higher risk for miscarriage, low-birth-weight babies, babies born with neurological, renal, and learning deficits (Centers for Disease Control and Prevention, 2015).

Elemental lead, by any means of exposure, is much more hazardous for young children than it is for adults (Abelsohn & Sanborn, 2010). Children are at a higher risk of health damage from lead exposure for several reasons. First, children spend more time on dusty floors and expose themselves more readily to lead in paint dust by hand-to-mouth behavior. Secondly, once exposed, children absorb lead in the gastrointestinal tract at a rate of 40% vs. 5% for adults. Thirdly, the blood-brain barrier and system of liver detoxification is not as mature as that of an adult (Abelsohn & Sanborn, 2010). For these reasons, it is important to minimize children's exposure so that they suffer minimal effects. Elevated BLLs in children ages 1-5 correlate with decreased cognitive function, as well as IQ levels (Levin et al., 2008). Not only is lead exposure shown to be linked to cognitive deficits, but exposed children are also at risk for hearing loss as well as reduced classroom performance (Environmental Protection Agency, 2018b; Sanborn, Abelsohn, Campbell, & Weir, 2002; Liu et al., 2014). These are issues that pose a threat to the child's—and future adult's—well-being. Deficits in learning and school performance can shape a child during their formative years and alter their ability to succeed academically as well as financially later in life.

Lead exposure and toxicity is much more than solely an individual medical issue. It is much more appropriately classified as a public health and social problem because the prevention of it is heavily dependent on factors outside the medical profession and it has population level impacts. Researchers claim that a notable point in the fight against lead exposure has been the budget cuts seen by a large portion of the country (Schneider & Lavenhar, 1986). These budget cuts have led to limited funding for testing and screening, resulting in decreased testing for children who had a potential for exposure. Decreasing the amount of testing each child receives gives the opportunity for long-term exposure to go untested, and untreated.

**Laws and Policies Addressing Lead Through the Years**

Science Progress, on their web page "A Brief History of Lead Regulation", provides a timeline of the history of the science, laws, and policies surrounding lead in the United States. Since the early 1900s, lead has been known to be a dangerous, toxic chemical was known to cause coma or even death. In the year 1922, lead was introduced into gasoline, causing much concern throughout the country about public health and safety. Throughout the following decades, commercial industries and scientists engaged in a battle of truth over the dangers of lead exposure to the public. In 1971, President Richard Nixon signed the *Lead-Based Paint Poisoning Prevention Act* which restricted housing built with federal funding from using lead paint. This led to the subsequent banning of lead in paint in 1976. In 1990, lead was banned from gasoline as an amendment to the *Clean Air Act of 1970* (Fowler, 2008). Lead plumbing, including pipes and solder, was banned in 1986 as an amendment to the *Safe Drinking Water Act*, although much of the infrastructure in the United States continues to predate the ban (American Association for the Advancement of Science, 2018).

In 2017 the National Sea Grant Law Center at the University of Mississippi published a report on the risks of lead contamination in water in the Mississippi Delta (Showalter-Otts & Janasie, 2017). It details the existing regulatory framework that addresses lead exposure, as well as the lack thereof. The framework that is in place includes the Safe Drinking Water Act (SDWA), the Lead and Copper Rule (LCR), and their respective roles in managing lead exposure in the United States. This report also details some of the challenges and gaps faced by the state of Mississippi with regard to lead exposure (Showalter-Otts & Janasie, 2017). One such challenge reported was that even though Mississippi reported 3,083 children with elevated BLLs (over 5 micrograms/dL), the rate is likely significantly higher as screening is not mandatory and the rate of testing has declined in recent years (Showalter-Otts & Janasie, 2017). These regulations, however, face some challenges and holes.

The SDWA, which was enacted in 1974 and amended in 1986 and 1996, is the primary federal law which regulates the quality of drinking water of the United States. Using a system called cooperative federalism, the Environmental Protection Agency (EPA) sets guidelines for water quality standards with which state and local governments as well as water suppliers must comply (Environmental Protection Agency, 2017b). The LCR is a series of regulations that attempt to address and control lead and copper contamination in drinking water by means of corrosion control throughout the distribution system (Environmental Protection Agency, 2017a). The LCR requires that public water systems test a specific number of households' tap water within a particular period of time. The number of homes required and the amount time within they must be sampled varies based on population and whether or not a water system has met certain criteria—i.e. reporting levels below the maximum contaminant level for three years (Showalter-Otts & Janasie, 2017).

In the state of Mississippi, the primary control for the SDWA regulation is the Mississippi State Department of Health. However, control by one body can be difficult, namely in Mississippi. "The distribution system for drinking water in Mississippi is incredibly fragmented. It is not uncommon for counties in Mississippi to have ten or more public water systems" (Showalter-Otts & Janasie, 2017, p. 14). This fragmentation makes it extremely difficult for Mississippi to oversee and enforce the rules and regulations for testing and monitoring. The SDWA and the LCR do not cover private wells, leaving non-public water supply users at risk for lead exposure. Another challenge in the regulations is that although lead plumbing was banned in 1986, the law did not require the removal or replacement of pre-existing infrastructure, meaning that any service lines established before 1986 run the risk of contaminating public water systems.

**Which Groups Are Most Affected?**

As mentioned before, children are at the highest risk of lead exposure due to their rate of absorption of lead through the gastrointestinal respiratory tracts. The groups most affected by lead exposure, however, fall into additional demographic categories. These groups are those that are already highly affected by public health issues across the country. They are the poor, minorities, immigrants, and those who work lower-class jobs. Many cases of childhood lead exposure are found in children who come from families with lower socioeconomic statuses (Muennig, 2009). This is especially notable because children who come from lower socioeconomic backgrounds already face several public health disparities. Minority children, primarily African American and Hispanic, are at a significantly higher risk of lead exposure and have much higher BLLs than white children, even after careful consideration of environmental and nutritional factors (Lanphear, 2005). Once again, this is an important distinction because African American and Hispanic children are already plagued by poverty at disproportionate rates, with 26.2% of the African American population living below the national poverty level--compared with 12.5% of white Americans (US Census, 2016). Poverty is known to correlate with poor health, which, when coupled with exposure to a neurotoxin such as lead, can lead to detrimental effects for the person exposed. In the publication "Lead Exposures in U.S. Children, 2008: Implications for Prevention", risk factors for elevated BLLs in U.S. children are higher in certain groups, such as the aforementioned minorities, immigrants and refugees, those who have a lower household income and parental occupations, age of housing, and location of residence (Levin et al., 2008). These statistics and observations are important because they shed light on those most affected, allowing for the people from areas most affected to serve as a model for future risk-analysis and intervention.

**Lead in Drinking Water**

It is important to note that the primary source of lead exposure is from lead paint dust (Levin et al., 2008). While the majority of literature surrounding lead exposure is focused on lead paint and its abatement, according to the Environmental Protection Agency (EPA), "Children are exposed to lead in paint, dust, soil, air, and food, as well as drinking water…EPA estimates that drinking water can make up 20 percent or more of a person's total exposure to lead" (Environmental Protection Agency, 2018a). If twenty percent of the risk of lead exposure comes from drinking water, then lead poses a significant threat to public health. One of the major risk factors for lead exposure is the pH of the water of the household. A more acidic pH (below 7) can cause lead to leach into the water (Kim, Herrera, Huggins, Braam, & Koshowski, 2011). This means that those households whose drinking water is more acidic are at a higher risk for lead exposure. The EPA requires that drinking water systems perform corrosion control to minimize lead contamination in drinking water (Environmental Protection Agency, 2017a). Corrosion control can help to increase the pH of water (decrease acidity) in order to prevent lead contamination and consequent exposure.

By focusing on drinking water as a major source of exposure, water tests and BLLs can be more closely monitored for characteristic areas known to have a higher risk of lead exposure. In order to focus on these areas, an analysis of the most at-risk areas and their characteristics must be done in order to create a system for determining similar areas. Bernard and McGeehin (2003) show that children who fall into certain demographic categories, such as African American and Hispanic children, are at a much higher risk of lead exposure. Data also showed that those living in older, poorly maintained, or newly renovated housing are also more likely to see elevated BLLs (Bernard & McGeehin, 2003). By analyzing the risk factors for key areas, generalized statements can be made that allow for the creation of a system by which other at-risk areas can be pinpointed. For example, if it is determined—by demographic analysis or other methods—that those living in older housing are at higher risk, then other areas where older housing is more common can be focused on to screen for potential lead exposure. Another study claims that "children are still being exposed to lead, and many of these children live in housing built before the 1978 ban on lead-based residential paint. These homes might contain lead paint hazards, as well as drinking water service lines made from lead, lead solder, or plumbing materials that contain lead" (Brown &

Margolis, 2012, p. 7). Recognizing the dangers of housing constructed before the laws enacted to control lead exposure can help to monitor areas that have older housing, screening for lead in particular. Roughly 69% of housing infrastructure predates 1989 (United States Census Bureau, 2016). Though lead was banned from plumbing in 1986, it did not require the removal of these plumbing systems from homes or public supply lines. This means that any housing built before 1986, which is likely the majority of housing, is still at risk for lead exposure.

As mentioned before, the risk of lead exposure does not solely lie within the household itself. Because the LCR and SDWA did not require the removal of pre-existing lead infrastructure, public water supply lines could still be at risk for contamination of public water supplies. Mississippi faces a particular challenge when faced with the issue of replacing these lead service lines. Federal law did not require states to retain records related to the LCR, meaning that many of Mississippi's municipalities and public water systems have little to no idea of where these lead service lines lie (Showalter-Otts & Janasie, 2017).

Mississippi is no stranger to lead exposure in drinking water. In 2016, the City of Jackson announced that of the 222 homes it had tested for lead, 24 registered for lead concentrations that exceeded the EPA action level of 15 ppb (Mississippi State Department of Health, 2017). With approximately 11% of tested homes above the action level, Jackson, MS residents are at a significant risk of exposure from lead through drinking water alone. This news first broke in January 2016 when the mayor of Jackson issued a warning to all residents that received water from the city that the proper corrosion control was not in place (Luckerson, 2016). In July 2018, the mayor of the city renewed the warnings about the city's drinking water, urging residents to consider alternative sources of water for drinking or cooking, such as bottled or filtered water (The Associated Press, 2018).

Jackson is not the only town to see the negative impact of lead in drinking water, however. One of the most jarring public health crises in the United States occurred in Flint, Michigan, when residents were subjected to drinking water full of contaminants, including lead. The many year legal battle between Flint residents and their city government is ongoing and the effects of this toxic exposure continue to permeate the community of Flint, a predominantly African-American community (The Associated Press, 2017). Although major strides have been made in the way of minimizing lead exposure in the United States, there is still much progress to be made in order to improve exposure conditions for all those exposed.

**Benefits of Lowering BLLs and Broader Implications**

Several studies have analyzed the risk of lowering BLL's, estimating the social, economic, and healthcare benefits of risk analysis, screening, and subsequent treatment of childhood elevated BLLs. The physiological benefits of lowering BLLs would have an immediate effect on the individuals affected. By lowering the levels of a damaging agent, there would be a direct improvement on cases of lead poisoning, as well as lowering risks of developmental deficits and neurological damage (Bellinger, 2008). Improvement of BLLs also has some implications that reach beyond the immediate physical benefits. Other benefits to reducing lead exposure include economic benefits. One such benefit is the reduction of health care costs. Gould goes on to explain these by showing that the total cost per year (as of 2006) for all children six years or younger whose BLLs were above 10 µg/dL can range from $10.8 and $53.1 million. She states, "Lead poisoning causes negative health effects later in life, such as neurologic disorders, adult hypertension, heart disease, stroke, kidney malfunction, elevated blood pressure, and osteoporosis" (Gould, 2009). Many of these are long-term effects that require constant medical care and intervention, most of which are costly. By reducing lead exposure, there would be a significant decrease in associated healthcare costs. Lifetime earnings can also see an effect from lead exposure. Strongly correlated with IQ, Gould goes on to estimate the actual cost of cognitive deficits for children with elevated BLLs, claiming that each lost IQ point represents $17,815 (in 2006 USD) decrease in lifetime earnings. Because lead is estimated to have caused a total of 9.3-13.1 million lost IQ points, that translates to a net lifetime earnings loss between $165 and $233 billion for all children under six years of age. This estimate includes the effects of lower educational achievement as well as workforce participation and lower hourly wages earned (Gould, 2009). This estimate shows the massive toll that lead exposure takes on the economy each year. This major loss of income and revenue, which, if improved, could help to bolster the economy as well as improve health, income, and workforce participation of those affected each year.

**Conclusion**

Lead exposure and elevated BLLs are an issue that affects many aspects of society and health, therefore this can no longer be considered solely a medical issue. Because so many people are at risk for the detrimental effects of lead, the problem must be addressed from an interdisciplinary perspective. By collaborative efforts by professionals from public health, medicine, educational institutions, and even members of the community themselves, the issue of lead exposure—specifically in drinking water—can be monitored and controlled. There are several strategies that can engage different stakeholders in the community, but the main methods discussed in the remainder of this study will be community-based, providing the basis for more involvement and greater ownership to members of the community who are affected by this problem.

## Research Questions

This project, which finds its roots in community partnerships and public health, sought to answer specific research questions about the effectiveness of community-based research with regard to a public health issue. The first research question that we sought to answer was whether multi-disciplinary, multi-method, and community-based approach to research provided more data to test for potential lead exposure. To follow that question, we also sought to answer whether these data can be used to inform better monitoring, outreach and education efforts. We also aimed to answer whether the methods used, and data gathered were effective enough to be used to inform policy for monitoring. We sought to find out what could be learned from piloting these types of interdisciplinary, community-based research projects. In terms of broader implications, another goal of this project was to see whether or not these types of community-based research can be used to improve more long-standing public health challenges than solely lead exposure. Throughout the next chapters the methods and findings from the collected data will be analyzed in order to discuss efficiency in answering these questions. The discussion of these findings will determine whether or not these data answered these questions effectively as well as the strengths and weaknesses of the overall approach.

## Hypotheses

Based on pre-existing literature, several hypotheses for analysis were postulated and tested in this project. The first hypothesis was that participants with a more acidic pH were more likely to have lead contamination in their drinking water. We also hypothesized that those who lived in older housing, primarily that which was built before the lead plumbing ban in 1986, were more likely to have lead in their water. Furthermore, we hypothesized that those households who relied on private wells for their drinking water were at a higher risk for lead contamination. Finally, we hypothesized that those participants who lived in houses (as opposed to mobile homes, apartments, etc.) were more likely to have lead in their drinking water.

With regards to qualitative data, we proposed that those workshops that had higher levels of engagement would have higher return rates. We also proposed that those workshops that worked with community partners which had some investment in health beforehand would also have higher engagement, and thus higher return rates. These propositions will be addressed in both the findings and methods sections.

## METHODS

Although there are several distinct types of community-based research, as outlined in the literature review, this project conducted in the Delta region of northwest Mississippi did not focus in on one particular type. Each type of community-based research employs commonalities that both incorporate the community and allows for meaningful participation aimed toward social change. A work in progress, efforts to build and refine strategies to support community participation and ownership, each workshop held for this study employed community-based research methods within the community. By acting alongside a pre-existing community partners, we were able to use these methods to create workshops that would allow us to create an atmosphere of engagement and participation in a public health setting. Though the individual methods varied by workshop, the general outline of methods followed a similar structure which can be tailored to fit individual events and communities. The general outline is presented here, however the specific variations are described and analyzed in the findings chapter.

### Organizing the Workshop

The first step in any CBR project is identifying the community and the group that will participate (Halseth et al., 2016). Following this practice, we (the university research team) established contact with an existing community partner who has strong ties to the community and those the project sought to reach. Ideally in CBR the community or a representative will approach the researchers through pre-existing ties and networks. When this project was first beginning, however, this was not necessarily the case. However, the project was able to find its beginnings with a pre-existing relationship with a community partner focused on health and youth development. In some of the later projects, community partners approached us and began the conversation through which a workshop was able to be organized. In order to follow guidelines of community-based research, many of the details were decided on by the community partner, sometimes including youth. Out of convenience or expected availability of participants, the time and location of each workshop was decided on a variety of factors, including—but not limited to—availability, pre-existing events or dates that would interfere with or encourage participation, as well as safety and accessibility of the location.

**Outreach and Education**

The second step is to engage constituents by means of outreach and engagement of stakeholders and community members (Hacker, 2013). Each community partner used their ties to the community to network and spread information about the workshop to all those who were needed to be reached (Halseth, et al., 2016). This outreach was established in a number of ways, such as through schools, churches, or other groups that cater to specific groups of individuals. At the workshops, the methods still followed a similar but variable structure. Each workshop featured an educational component about both the project and the dangerous effects of lead. After giving a brief overview of the project, we facilitated a discussion of the dangers of lead, ensuring that all those present were aware of the neurotoxicity and other threats that lead poses as well as ways to minimize risk of exposure (i.e. not cooking with water from the hot water tap). After the discussion, each person was given a flyer that detailed and listed all of the dangers of lead that had been discussed previously in the group. This informational document was available for everyone to take home after the workshop.

The project information was a brief overview of what we intended to do with the survey data, the methods, and the lead samples. We explained to the groups that their data was completely confidential, save for the address they provided for us to mail their results. During the discussion of the project, we explained that each household would have their water sampled and their results mailed to them after the analysis was done. After the informational discussion, we distributed surveys to each household that asked questions based on socioeconomic status, race and ethnicity, age of housing, housing characteristics, etc. We gave one bottle to every household who completed a survey, explaining to them both verbally and in print the methods of collection. Along with the directions for sample collection, the group was given a time frame and location for bottle drop-off so that a team member, often working with the community partner, could retrieve and return them to the lab for testing. The pick-up was set one week from the workshop, so as to ensure enough time to return to the lab during the viable testing window (14 days).

After retrieval, the bottles were brought back to the lab where they were analyzed via inductively-coupled plasma mass spectrometry (ICPMS). Methods for testing will be discussed in the next section. After analysis, the results were sent to the mailing address listed on the survey, along with helpful information including educational materials, ways to reduce lead exposure, and in some extreme cases, a certified filter that removes lead. Data from each survey questionnaire was entered into an SPSS database alongside lead concentrations. These data were analyzed using descriptive statistics and cross tabulations. Survey data for participants who did not return a water sample were excluded, so as to analyze solely the characteristics and results from those who returned a survey and a water sample.

**Methods for Testing**

At each workshop, individual households were given bottles in which they were to collect their water samples. Instructions were given verbally as well as printed on the bottle. Instructions were constant throughout testing, so that each household was supposed to follow the same protocol. The water sample obtained was to be the cold-water tap where the majority of drinking water comes from, and first catch of the day. This means that if any lead were to leach out into the water, it would have had time to do so overnight. The instructions also include a disclaimer that filters should be removed before the collection. The water was to be collected to the fill line and sealed. In order to ensure maximum accuracy, the samples were collected within one week. The water must be acidified two weeks post-collection, or the sample would be invalid.

Once collected from a central drop off point, the samples were taken back to the lab for analysis by ICPMS. First, the pH of each sample was measured and recorded, then the samples were acidified using 3 mL of 50% $HNO_3$. The samples were then mixed well and allowed to sit overnight (at least 16 hours). The pH was then tested again to ensure it was below 2. If not below 2, it was reacidified, allowed to sit, and then tested again. If the pH measured below 2, 10 mL of the solution was placed into a conical tube and 200 uL 50% $HNO_3$ was added. The sample was then refrigerated until ready for analysis by ICPMS. The standard curve values of each run on the ICPMS were 0, 1, 5, 10, 50, 100 ppb with the exception of the last run (0, 0.05, 0.1, 0.5, 2.0, 5.0 ppb). The results of lead concentrations were then entered into the SPSS data file with the corresponding participant code for further data analysis.

**Methods for Efficacy and Efficiency Analysis**

Each workshop was analyzed for efficiency by several methods. The first being a purely quantitative method of bottle return rate. Based on the number of bottles distributed and of those bottles how many were returned, a percentage was calculated and was used as a means of comparison between workshops.

The second method of analysis was also quantitative and dealt with cost effectiveness. In order to calculate costs, factors including time for the workshop, time for travel, mileage, time for data entry, cost of bottle testing, and other associated costs. The University of Mississippi Center for Population Studies (CPS) pays undergraduates, graduate students, and paid staff different hourly rates. Undergraduate students are paid $11.25, while graduate students were paid $11.50 for 2017. During the collection period, students paid hourly had a 3% fringe rate. Staff members were paid by the CPS at a rate of $15.03, the same hourly rate, but with a 32.26% fringe rate included. Costs for time were calculated using the time dedicated to travel, workshop length, data entry, and travel for bottle pickup. According to Independent Sector, the average cost of a volunteer hour in the state of Mississippi is $19.81 (https://independentsector.org/resource/vovt_details/). This value was used to calculate the cost of volunteer hour time for community partners that were not associated with the University of Mississippi. Because team members were reimbursed for travel costs, the University mileage reimbursement rate of $0.545 per mile was used to calculate mileage costs to and from UM to the designated workshop location as well as to the designated bottle drop-off location. Another value included in cost analysis was the cost of postage to mail results back to participants. This value was calculated using the cost of one United States postage stamp, valued at $0.50 per stamp, multiplied by the number of bottles returned and consequently tested. The final value included in cost analysis was the cost of testing the lead content via ICMPS. One tank of argon gas costs approximately $483 and can be used for around 100 samples. This value leaves the cost to test the lead content of one bottle at $4.83. This value was multiplied by the number of bottles returned and analyzed to find the final costs. All associated costs were then totaled.

Because community-based research is based on much more than solely quantitative data, this project was also internally analyzed for effectiveness using qualitative assessment of educational components, organization, and outreach. Firstly, a field memo description of each event and its bottle return, location, and community partner was distributed to all team members. This write-up allowed team members to compare different workshop models side by side as well as submit feedback and note strengths and weaknesses. A separate questionnaire was distributed to all team members, student researchers, and community partners/organizers (not participants) who engaged in any workshop or other collection event. The questionnaire asked responders to mark their role in the project, and whether or not they attended each particular event. If the responder indicated they attended the event, they were asked to answer several questions ranking different aspects of the collection event using the Likert scale (strongly disagree to strongly agree). This method of qualitative analysis allowed us to analyze more than just return rates and cost effectiveness, but also engagement of participants and participation. Based on these results the efficiency of engagement, education, and outreach were measured on a uniform scale for all workshops.

## FINDINGS

As mentioned before, each workshop followed a similar outline, though each varied individually. In this chapter, each workshop will be detailed along with strengths and weaknesses, cost effectiveness, and the results of the internally distributed survey detailing team members reflective insights on each workshop. This chapter will also include results from analysis of survey and water data from participants who turned in both a bottle and a questionnaire. It is important to note that for those workshops that did not sample any wells, this was not by design, but rather purely coincidental, thereby contributing to the need for a well-specific event.

### Community Engagement Event A

The pilot workshop for this project was held in Clarksdale, MS at Coahoma Community College on September 22, 2016. Information about the project and educational materials about the dangers of lead exposure as well as how to minimize this risk was given via a presentation and group discussion. Each household was given a consent form and survey which they then filled out on-site. Upon returning these materials to team members, the households were then given a bottle and verbal instructions on how to collect the sample. These instructions were also printed on the bottle. Each household was given a central location at which they could drop off their bottle where it was collected by a team member, as well as a time before which it had to be at that location.

#### *Strengths*

Within this project, participants—primarily middle schoolers and their families—were ready to invest in the project because they already belonged to one of two groups focused on health improvement. The workshop location was easily accessible for participants and was a neutral location, Coahoma Community College. Project information was disseminated through a verbal presentation and a group discussion, participants were able to learn more about the dangers of lead, as well as how to minimize risk. Another strength found in this workshop is that not only were middle schoolers who were already invested in better health engaged, but also the parents of those children. By bringing both parents and children together, participants were engaged in learning and improving their health together with their families. Bottles were only distributed after the survey was returned completed, helping to ensure that as many surveys and bottles were returned as possible. Participants were able to drop off the bottle at a central location in Clarksdale during working hours for a week after the workshop. A team member picked these returned bottles up at the end of that week and returned them to UM for testing. After testing, each household was sent an individualized letter detailing their results, how to minimize risk of exposure, and more information about the dangers of lead.

*Weaknesses*

This pilot workshop, however, did face some challenges. One such challenge is that participants were primarily from Coahoma County (63%), leaving the data relatively unvaried with respect to geography. The workshop was also held on a Thursday night, which might have been inaccessible for some potential participants who work during that time. Though the location at which they could drop off their bottles was in a central location, it might have been inaccessible to families who have little or no access to transportation. This workshop also was lacking in that no private wells were sampled, only public water systems, though this was unplanned. A common complaint about this workshop from team members was that though this was a solid pilot event, it was slightly disorganized and possibly distracting for participants due to the number of activities occurring at the same time.

Another weakness is that at this workshop, there were no print materials on the dangers of lead exposure, meaning that participants only learned through the verbal discussion.

*Internal Survey*

The survey that was distributed among team members and community partners allowed us to analyze the effectiveness of the community-based research methods employed at this particular workshop. For clarity, "strongly disagree" and "disagree" were grouped into one category and "agree" and "strongly agree" were grouped into another. For this workshop, there were 6 respondents to this survey. Of the six respondents, 100% agreed that both the location of the event was accessible to participants and that the number of participants met their expectations. Of these respondents, all agreed that organizers were thoroughly engaged in the event, while only 5 of respondents agreed that participants were thoroughly engaged. While 67% of respondents (4 out of 6) agreed that the educational component of this workshop was effective, 17% said that they disagreed. However, 83% of participants agreed that the project explanation and recruitment component of the workshop was effective and successful. Overall, all respondents agreed that the event met their overall expectations. A common sentiment that respondents felt is that this workshop was slightly disorganized and that participants may have been distracted due to the number of activities available for them to do. However, respondents also noted that they thought the workshop was strong, specifically for the pilot event in the project.

*Quantitative Measures*

Each workshop was also evaluated quantitatively by both bottle return rate and cost effectiveness. For this workshop, the estimated costs of faculty, staff, student, and community partner hours were totaled with mileage reimbursement costs, sampling costs, and postage costs. **Table 1** shows the number of bottles distributed at the event (n = 52), the number of bottles returned (n = 38), and the percent return rate, which was 73.1%. Taking into account costs for time, sampling, postage, and travel, the cost of the workshop totaled approximately $826.85, with an average cost per bottle returned of $21.76.

**Community Engagement Event B**

The second workshop, which was also held in Clarksdale, MS at Coahoma Community College, followed similar methods as the pilot workshop. The community partner at this event was the same as the first, but with a new cohort of high school students and their parents from five counties. At this workshop, project information as well as educational information was given via a presentation and discussion. After the discussion, each household was given a survey and asked to participate. Upon returning the survey they were given a bottle with instructions in print on the side, as well as verbal instructions from a team member. Bottles could be dropped off at a central location over the following week. This location was set by the community partner. One week after distribution, the bottles were then collected from this location.

*Strengths*

A pre-existing relationship with the director of the community organization as well as their participation in the pilot workshop led to a successful workshop with good participation and investment. The workshop invited students and their parents, inviting families to come and participate in both learning and action to improve their health. The structure of the workshop allowed participants to ask questions or voice concerns directly to team members so that they could be addressed. Another strength of the event was the involvement of students which created the opportunity to lay a foundation for future involvement, partners, or participation. Because the bottles were not distributed until the survey was returned, this helped to ensure that the best return rate of surveys and bottles was met. As with the previous workshop, individualized letters were shared with each household detailing their results, what could be done to minimize risk, and other informational material. This workshop also saw a much more geographically varied group, with 23.3% of households from Bolivar County, 33.3% from Coahoma, 30.0% from Quitman, and 13.3% of participants from Tallahatchie. This variety was in part because students in this cohort were a part of a student organization that spanned multiple counties.

*Weaknesses*

As with any community-based research event, there were some challenges. The first being that the workshop was held in Clarksdale, MS on a Tuesday, again potentially making it difficult for those who have inflexible work schedules or transportation difficulties to attend. As with the pilot workshop, this event sampled no private wells, meaning all of the samples were from public water systems. The lack of wells in the sample was not by design, as this event was open to all students and families within the organization, regardless of their water source.

*Internal Survey Results*

Four team members and community partners responded to the internal survey, which also allowed us to analyze the effectiveness of this workshop. Of these respondents, 100% (4 out of 4) agreed that the workshop location was accessible to community participants, as well as whether the number of participants at the event met their expectations. All respondents agreed that the organizers of the event were thoroughly engaged in the event, while 75% (3 out of 4) of respondents agreed that community participants were thoroughly engaged. While half the respondents agreed that the educational component was effective, 25% disagreed. With regards to the project explanation and recruitment component, however, 100% of participants agreed that it was effective. All of respondents agreed that the event met their overall expectations. One comment that we received from this survey was that the educational component and project message may have been lost in the "flurry" of the evening's activities.

*Quantitative Measures*

The second workshop in the project saw a marked increase in return rates but also in cost per bottle. **Table 1** shows the number of bottles distributed (n = 36), the number of bottles returned (n = 30), and the percent return rate, which was just above 83%. This increase in return rate, however, did not help to minimize costs per bottle, which increased from the first workshop. This table also shows the total costs incurred as well as the cost per bottle.

**Community Engagement Event C**

This workshop, which worked with a different community partner (related to a maternal-child health group), was held in Belzoni, MS. The workshop was marketed toward a church cohort through said community partner. The participants were given a time frame through which the workshop would occur, so there was significant traffic in and out of the workshop. Project information was disseminated primarily through the community partner throughout the church, while educational material was solely in print given to participants in conjunction with the survey and consent form. Upon return of the survey and consent form, participants were distributed a bottle with verbal and printed instructions given. The community partner collected bottles by traveling to each individual home in order to collect them.

*Strengths*

Through this workshop, a trusted member of the community was able to do outreach and share information with church members about the project and the workshop.

With regard to educational materials, participants were given a document that details the dangers of lead and the risks of exposure, which they were able to take home with them. Throughout the workshop, team members were available for participants to ask questions or voice concerns. Participants were given a bottle after returning the survey and consent form, helping to maximize bottle and survey return rate. Because the community partner individually collected the samples, the return rate for this event was 100%. After tests were run, each household was sent an individual letter detailing their results as well as how they could minimize their risk of lead exposure.

*Weaknesses*

The first challenge this workshop faced was that outreach was limited to a church congregation, so participation of community members who were not a part of the congregation was minimal. Another significant challenge was that no full group presentation was given about the risks of lead exposure, only a document that participants could take home. Many participants turned the informational document back in with the consent and survey and were not interested in taking it home with them. This removed the group discussion, participation, and education dynamic that this project aimed to promote. This method of education also posed a problem for a least a few participants who could not read. These same participants faced issues when attempting to complete the consent form and survey. Another challenge, faced primarily by our team, was that the community partner marketed the event as a "come-and-go" event, throughout which participants would leave or come in an hour late. This posed problems because it made it difficult to disseminate information and educational materials. It also made the workshop difficult because team members had to repeat information multiple times about how to fill out the survey and other basic, yet necessary, information. This workshop was also held on a Thursday, during the work week, potentially causing issues for any community member who had an inflexible work schedule or transportation issues. One of the primary challenges with this event was the method of bottle collection. The bottles were collected at each individual home, and there was no way to ensure that samples were collected first catch of the day from the kitchen sink. This event also did not have any wells returned, so the samples were all from public water systems. Another potential weakness in this workshop was that the community organizer was paid, so financial compensation was a factor in community participation.

*Internal Survey Results*

When asked via survey about the workshop in Belzoni, three team members and community partners responded. Approximately 67% (2 out of 3) of respondents agreed that the event was accessible for community members; and the same percent agreed that the number of participants met their expectations. All of respondents agreed that organizers of the event were thoroughly engaged, while 67% disagreed that participants were thoroughly engaged. All respondents disagreed that the educational component was effective, while 67% agreed that the project recruitment and explanation was effective. One-third of respondents agreed that the overall event met expectations, while 33% disagreed. One common complaint was that there was a disconnect between community partners, participants, and organizers. The message seemed to be lost somewhere between what was expected of each party that participated.

*Quantitative Measures*

This workshop, held in Belzoni, MS, saw a significant increase in bottle return rates from the previous two workshops, although there were some inconsistencies and concerns with the methods of collection from these bottles. However, **Table 1** shows the number of bottles returned (n = 42) equals the number of bottles originally distributed (n = 42), giving a

100% return rate. This table also shows the cost analysis of this workshop, including total costs incurred and cost per individual bottle. The cost of the workshop was the highest of all the workshops, with a total associated cost of $1101.16, however it had the third lowest cost per bottle to sample, costing just around $26.22 per bottle.

**Community Engagement Event D**

This collection event was held in Charleston, MS with a community cooking class. Team members visited the cooking class and gave a brief presentation about the project and held a group discussion about the risks of lead exposure. Surveys and consent forms were distributed to participants who were then given a bottle upon the return of those materials. Instructions for sampling were given verbally as well as printed on the bottle. One week later, bottles were collected by a team member from the same location at the same time at the weekly cooking class.

*Strengths*

A convenient and useful aspect of this event was a pre-existing event (the cooking class) that participants were already planning to attend. This worked for both availability—as participants knew they would be at the cooking class—and for bottle drop off. An in-person discussion and presentation allowed participants to voice questions or concerns. Much like the previous workshops, participants were given a bottle upon return of a survey and consent form, helping to ensure maximum bottle and survey return. The consistency in bottle distribution and collection was a strength that also helped to maximize bottle return. The results of each individual household's sample were sent via a letter to their mailing address, along with information about how to minimize risk of exposure. In this workshop, some wells were introduced into the data, helping to vary the sources of the water samples in the data.

*Weaknesses*

Because this event was in partnership with a pre-existing cooking class, the need for extra outreach to the community about the project was non-existent. Participants were all members of the cooking class, meaning that community members who were not a part of the class were not informed or able to attend. The class was also held on a Monday evening, making it difficult for people with inflexible work schedules to attend. This means that accessibility for all community members may have been low.

*Internal Survey Results*

For this particular event, there was only one respondent to the survey. This respondent agreed the location was accessible for participants, while they disagreed that the number of participants met their expectations. They also disagreed that the organizers of the event were thoroughly engaged. In contrast, they agreed that participants were thoroughly engaged in the event. This respondent agreed that both the educational and research project explanation and recruitment components were effective. They disagreed that the overall event met their expectations.

*Quantitative Measures*

Of the 10 bottles distributed at this workshop, 6 of them were returned (60%). Though this workshop was one of the more inexpensive workshops in the project in terms of overall costs, it was relatively inefficient in terms of cost per bottle. Overall, the total cost fell just below $350.00, the least costly workshop of all to date. However, because of such a small number of bottles returned, the cost per bottle was approximately $57.00, a relatively inefficient value when compared with other workshops' costs (**Table 1**).

### Community Engagement Event E

This event was held in partnership with a community breastfeeding-support program. At this workshop, called "Train the Trainer", participants (employees of the program), met with a team member in Indianola, MS. This workshop used the method of discussion and presentation to explain the risks of lead exposure and how to minimize those risks. Each participant was given three questionnaires and three bottles, one of each for their household, and the other two of each for family, friends, or neighbors. These employees were given instructions on how to distribute the documents and the bottles to whomever they chose, as well as the instructions for water sample collection. After two weeks, the bottles were collected by a team member in Indianola, MS.

*Strengths*

Through a pre-existing partnership between the Center for Population Studies and this program, this workshop allowed health professionals, social workers, and lactation consultants to come together and discuss the risks of lead exposure. Not only were these employees present, but they were also given the opportunity to educate and involve others. Bottles were returned to a central location which were picked up by a team member. The results of each sample were then mailed to individual households informing them of their results as well as techniques to mitigate lead exposure. Because participants were already engaged in their community and were employees of a health-promoting organization, the bottle return rate was ideal at 100% return. This workshop, because it taught the participants to become facilitators themselves in a way, maintained the spirit of community-based research which engages community members in such a way as to help them learn to conduct the research themselves.

*Weaknesses*

Although this workshop had several strengths, it also faced several challenges, the first being that only one core team member was present (along with the community partners), potentially causing difficulties in group discussion and information distribution. Another challenge for participants could have been that the workshop was held on a Wednesday, during the work week. Bottles also had to be dropped off at a central location, which could have caused problems for people who could not access this point during normal working hours or because of transportation issues. The water sample collection was not monitored for this event; neither was the distribution of information, survey, and bottles from the employee to the other participants. This means that consistency in sampling and proper dissemination of information could not be monitored or controlled. This workshop also sampled no private wells, only public water systems.

*Internal Survey Results*

There were two respondents for the internal survey about this particular event. The respondents both (100%) agreed that the setting was accessible for community participants, that the number of participants met expectations, that organizers and community participants were thoroughly engaged, and that educational and recruitment components were effective. All respondents agreed that the event met the overall expectations. One comment left by respondents stated, "Those conducting the community event were well-trained and effective in their communication with participants. They were enthusiastic about the study and saw the value of it."

*Quantitative Measures*

At the workshop held in Indianola, MS, bottle distribution and return rates, though done in a slightly different manner than the rest of the workshops, still saw an ideal return rate of 100% (**Table 1**). This workshop was also a relatively inexpensive workshop, totaling just over $400 at a rate of $34 per bottle (**Table 1**). This workshop, though small, was relatively efficient in both cost effectiveness and return rates.

**Community Engagement Event F**

By joining with a different university's pre-existing project where private well owners could have their water tested for bacteria, participants could also have their water tested for lead in a workshop held in Batesville, MS. Because the pre-existing bacteria test had an associated cost of $25 a sample, funding for our project was used to cover these costs so as to remove any socioeconomic barriers for any who wished to participate. Participants could pick up a bottle, survey, and consent form during the working hours on their own time from a public office in Batesville, MS. Participants had the option to drop off bottles and surveys during the week on their own time.

*Strengths*

This event was an intentional effort to focus on housing units with wells, which was a successful part of this particular event, adding fifteen wells to the data. Another strength of this workshop is that it targeted Panola County, which has been flagged as a high-risk area in other research. This event took advantage of a pre-existing water testing opportunity for participants, allowing us to partner with this project for outreach and participation. Participants had the opportunity to pick up and drop off bottles on their own time and at their own convenience, helping to minimize some of the barriers of time restraints for participation. Materials could also be dropped off throughout the week at participants' convenience. One of the more tangible strengths of this workshop is that those participants whose lead levels exceeded 5 ppb (6 households) were sent drinking water filters that remove lead.

*Weaknesses*

Because participants had the option to pick up and drop bottles on their own time, they did so and did not attend the workshop. Since they did not attend, the participants were not able to learn more about the risks of lead exposure or become active participants in their understanding and minimization of these risks. This removed the idea of engaging people in their own health and created a dynamic similar to traditional academic research.

*Internal Survey Results*

There were only two respondents to the internal survey for this event. One respondent disagreed that the event appeared accessible for community participants, while the other one neither agreed nor disagreed. Both respondents disagreed that the number of participants at the event met expectations. One agreed that the organizers of the event were thoroughly engaged and one disagreed; one disagreed that community participants were thoroughly engaged in the event and one neither agreed nor disagreed. Both respondents disagreed that both the educational component and the project recruitment and explanation was effective. Both respondents also disagreed that the event met their overall expectations.

*Quantitative Measures*

At this particular workshop, the bottle return rate was relatively high, with 71.4% of 28 bottles being returned. However, because of the special costs of covering a $25 fee with every bottle that was tested, this workshop became costlier than most. With a total cost of $910.39 and a cost per bottle of $45.52, the workshop was not the most cost effective.

**Community Engagement Event G**

High school students who were members of a pre-health professions group and school health council held a health fair in Ruleville, MS, at which our team had a table with project information available to any students who wished to participate. This event was held at the

North Sunflower Medical Center (a rural hospital). Students in attendance were members of the health interest groups as well as students from the Sunflower Consolidated School District. At this event, a brief overview of the project was given, as well as one-on-one discussions with students, or small groups of students. A poster was set up behind the table where students could read more about the dangers of lead and two team members were available to discuss with any student interested. Because the students were primarily under 18, they were given a bottle, a consent form, and a survey which they carried home to their parents so that they could participate. Bottles and surveys could be dropped off throughout the week at a central location in Drew, MS.

*Strengths*

For this event, an existing community partner with strong ties to other community leaders helped to expand the project to more students from several different schools and communities. Because this event was set up as a health fair, students could walk around the room at their own pace, allowing them to not feel rushed and approach the table at their convenience. Many young adults participated and were very enthusiastic about learning more about their water quality. The poster available helped to foster this enthusiasm by providing a visual element that helped to explain the project, lead information, and how to minimize risks. Despite having to send consent forms, surveys, and bottles home with minors, the return rate was very high, at 91.3%.

*Weaknesses*

There was no large discussion that took place, so the educational material primarily came from the poster, the printed document, and one-on-one discussions of the dangers of lead. Because individuals could come and go as they pleased, simple but important information had to be repeated many times and it was unclear how much each participant had heard before fully engaging in the conversation. A major challenge that this event faced was that the majority of attendees were under the age of 18, so they could not fill out the survey and consent forms without parental consent. These materials had to be sent home with the bottles, risking low return rates and many lost bottles and surveys. The bottles were then dropped off at a central location in Drew, MS, which could have been difficult for those students who do not live in Drew. Another challenge faced by this workshop is that some bottles were returned with a water sample in them, yet the survey and consent form were blank.

*Internal Survey Results*

For this particular workshop, there were four respondents to the internal survey. Of these respondents, 100% agreed that the setting of the event was accessible for community participants. However, 75% (3 of 4) agreed that the number of participants met expectations, while 25% disagreed. All of respondents agreed that both community participants and event organizers were thoroughly engaged. Everyone also agreed that both the educational and recruitment components were effective and that the event met overall expectations.

*Quantitative Measures*

This workshop, as detailed in **Table 1**, was one of the highest return rates that we had for all the workshops, despite that all the materials were sent home with students under 18. Of the 22 bottles distributed, nearly 91% were returned. The overall cost of the workshop was not extremely costly, yet it was not inexpensive either. The cost per bottle was the median price per bottle, at slightly less than $38 per bottle.

**Community Engagement Event H**

This event was held in Batesville, MS on June 4th and June 7th, 2018 in partnership with a community health center. The informational booth was set up in the back by the nurses' station where patients had to pass the table before going to pay, submit prescriptions, etc. The table had a poster display in order to add a visual element where patients could read about the project and the dangers of lead. Chairs were set up in front of the table in case participants wanted to sit and discuss the project with a team member. As patients came out of the room, team members asked if they were interested in participating in the project. For those who chose to participate, they were given a survey and consent form and asked to complete it. Upon completion of these forms, participants were given a bottle and verbal instructions on how to collect the water. Instructions were also printed on the side of the bottle for those who needed it. One week following distribution, a team member returned to the clinic to collect the bottles.

*Strengths*

Because this was not a group event, participants were able to have a one-on-one discussion with a team member. This allowed for more open conversation between them. The bottle drop-off location, because it was at the same place the participants picked it up, was convenient and easily accessible to participants. The poster allowed participants to read about the dangers of lead at their own pace and added a visual element that helped to capture people's attention. This workshop was done in Panola County which has been flagged as a high-risk county for lead exposure.

*Weaknesses*

This workshop, which was done using different methods than earlier events, faced several challenges. The first being that participants were typically approached at the clinic, rather than approaching us, a tactic that could have made several participants uncomfortable. Another is that at this particular clinic, the table was set up behind a closed door where participants were not allowed access until their visit was over. This means that most potential participants did not want to stay and spend time discussing the dangers of lead after their visit was finished. Another challenge was that participants had to come back to the clinic to return their bottle. This could have been difficult for people who had already taken time out of their week to come to the clinic and who could not afford to do so a second time to return the bottle during working hours.

*Internal Survey Results*

For this event, there was only one response for the internal survey. This respondent said that they agreed that the event setting was accessible for community participants, while they disagreed that the number of participants met their expectations. They agreed, however, that both organizers and community participants were thoroughly engaged in the event. They also agreed that both the educational and recruitment components of the workshop were effective. Overall, they agreed that the event met their expectations. One issue that this responder noted was that the location at the health center hindered participation and that other locations in the community may have been better suited for this event.

*Quantitative Measures*

**Table 1** details the results of the cost analysis of this workshop. Of the 4bottles distributed, 111 were returned (45.8%). This workshop, though not the costliest, had a total associated cost of $476.82, with the cost per bottle totaling just below $40.

**Community Engagement Event I**

This event was held in Tunica, MS on June 11th and June 14th, 2018 in partnership with a community health center. At this event, the table was set up in the waiting area with a poster setup for a visual element and team members available all day. This workshop also had several other signs, notes, and informational materials available for participants. After patients had checked in, a team member asked them if they would be interested in the project.

If they agreed, they were given a consent form and survey and asked to fill these out. Upon return of these materials, participants were given a bottle as well as verbal instructions for sample collection. The instructions for collection were also printed on the bottle. One week after the second event, a team member traveled to the clinic to collect the bottles returned.

*Strengths*

At this workshop, the poster and available team members added a visual element that helped to spark conversation and improve discussion between the participants and team members. Because this table was set up in the waiting room, patients could talk with team members while they waited, rather than at the end when they were ready to leave. Many nurses and staff members were interested in participating, and some participants were encouraging others to participate as well. The bottle drop-off location, which was just at the clinic, was convenient and accessible for participants.

*Weaknesses*

Because participants were required to come back to the clinic, it could have been difficult for them to find time in their week—after just having taken time out to visit the clinic the first time—to return the bottle. Participants could also have been uncomfortable. At this particular event, there was an issue with a language barrier where a participant and the team members did not speak the same language, so despite the family's interest in the project, participation was nearly impossible for them.

*Internal survey*

There was only one respondent for the workshop in Tunica from the internal survey. This respondent agreed that the event was accessible for participants and that the number of participants met expectations. They also agreed that both organizers and community participants were thoroughly engaged. The respondent stated that they agreed that both the educational and project recruitment components were effective. Overall, they claimed that the event met expectations.

*Quantitative Measures*

At this workshop, 44 bottles were distributed and only 36.4% were returned. The total cost associated with this workshop was just below $700, with cost per bottle totaling approximately $41. This was not the costliest workshop, but the price per bottle for this event was rather expensive. **Table 1** shows the itemized costs of the workshop.

**Table 1. Quantitative results of efficacy and effectiveness analysis.**

| **Event** | **Water Samples** | | | **$ Costs (USD)** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **# Bottles Distributed** | **# Bottles Returned** | **% Return** | **Personnel** | **Travel** | **Sample Analysis** | **Postage** | **Total** | **Total Per Bottle** | **Cost per Bottle Excluding Travel Costs** |
| **A** | 52 | 38 | 73.1 | 513.73 | 70.96 | 183.54 | 19.00 | 826.85 | 21.76 | 6.37 |
| **B** | 36 | 30 | 83.3 | 513.73 | 70.96 | 140.07 | 14.50 | 778.88 | 26.86 | 6.69 |
| **C** | 42 | 42 | 100 | 634.18 | 124.26 | 202.86 | 21.00 | 1101.16 | 26.22 | 8.16 |
| **D** | 10 | 6 | 60.0 | 214.51 | 56.90 | 28.98 | 3.00 | 343.01 | 57.17 | 11.93 |
| **E** | 12 | 12 | 100 | 184.45 | 119.9 | 57.96 | 6.00 | 407.93 | 33.99 | 8.63 |
| **F*** | 39 | 20 | 51.3 | 235.83 | 28.34 | 96.60 | 10.00 | 910.39 | 45.52 | 32.31 |
| **G** | 22 | 20 | 90.9 | 469.03 | 93.63 | 101.43 | 10.50 | 793.45 | 37.78 | 10.99 |
| **H** | 24 | 11 | 45.8 | 245.03 | 28.34 | 57.96 | 6.00 | 476.00 | 39.67 | 16.89 |
| **I** | 44 | 16 | 36.4 | 383.03 | 82.513 | 82.11 | 8.50 | 694.82 | 40.87 | 13.49 |
| ***Total*** | ***295*** | ***195*** | ***66.1*** | ***4162.05*** | ***824.04*** | ***951.51*** | ***98.50*** | ***6332.49*** | ***36.65*** | ***12.83*** |

*Community Engagement Event F incurred a special cost for each sample.

*Survey and Water Analysis*

One goal of this project was to determine whether community-based principles can be used to inform proper outreach and monitoring. An important aspect of answering this question is data analysis. In order to determine which geographic areas or which demographic groups could potentially be more at risk, frequencies and cross tabulations were run in order to identify any associations in the data. **Table 2** is a descriptive table that details general characteristics of the respondents. In order to provide consistency in analyses, only participants who returned both a bottle and a survey were included. **Table 3** details the results for a general descriptive table of results for lead and pH levels of participants.

**Table 2. Lead in water project overall household characteristics**
(Households returning both questionnaires and water samples, n=195)

| Characteristics | | *f* | % |
|---|---|---|---|
| Housing tenure (n=189) | Renters | 54 | 28.6 |
| | Owners | 126 | 66.7 |
| | Other arrangement | 9 | 4.8 |
| Housing type (n=193) | House | 146 | 75.6 |
| | Mobile home | 22 | 11.4 |
| | Apartment/Other | 25 | 13.0 |
| Know when built (yes) (n=184) | | 101 | 54.3 |
| Built 1985 or earlier (yes) (n=93) | | 44 | 43.6 |
| Pipes ever replaced (n=174) | Yes | 32 | 17.4 |
| | Unsure | 72 | 39.1 |
| | No | 80 | 43.5 |
| Use filter for drinking water (yes) (n=194) | | 56 | 28.9 |
| Use filter for ice (yes) (n=194) | | 57 | 29.4 |

**Table 3. Lead and pH levels in overall water project testing results (ppb)**
(Households returning questionnaires and water samples, n=195)

| Characteristics | Lead (ppb) | pH |
|---|---|---|
| Mean | 0.84 | 7.71 |
| Median | 0.22 | 7.79 |
| Standard deviation | 1.92 | 0.53 |
| Minimum | 0.00 | 5.84 |
| Maximum | 14.32 | 9.13 |

As seen in **Table 4**, each participant was grouped into one of six groups, each concerning the concentration of lead found in their water. More than one-third of households had no lead content found in their water. Approximately 43% of households had a lead content found between 0.05 ppb and 1 ppb. There is no safe level of lead, so this means that these households are at risk for the dangerous effects of lead exposure.

**Table 4. Lead concentrations recoded into categories.**

| | Level | *f* | % |
|---|---|---|---|
| Lead levels (ppb) (n=195) | No lead detected | 74 | 37.9 |
| | 0.0001 to 1.0000 | 86 | 44.1 |
| | 1.0001 to 4.9999 | 26 | 13.3 |
| | 5.0000 and above | 9 | 4.6 |

Nearly 62% of households were found to have some lead content in their water. While no household exceeded the EPA action level of 15 ppb, almost 5% of samples tested exceeded 5 ppb, the warning level for lead exposure from the FDA.

The data were also analyzed for associations between lead content and the source of the water. This analysis showed that participants who relied on a private well (or non-PWS) for their water were more at risk for lead exposure. While approximately 57% of participants whose water came from a public water system had lead in their water, 87% of participants who relied on well water had detectable lead concentrations. The Cramer's V for this analysis was 0.283, showing a moderate association between lead in drinking water and the source of the water.

**Table 5. Lead content based on source of water (n=186).**

| Lead in Water | Public Water System | Private Well/Other |
|---|---|---|
| No Lead | 42.9 | 13.0 |
| 0.0001 to 1.0000 | 42.9 | 43.5 |
| 1.0001 to 4.9999 | 11.7 | 21.7 |
| 5.0000 and Higher | 2.5 | 21.7 |
| Total | 100%<br>(n=163) | 100%<br>(n=23) |
| Cramer's V | 0.283 | |

Acidic pH has been shown to cause lead to leach from pipes into the water supply (Kim et al., 2011). The data were analyzed for associations between pH and lead content (**Table 6**). pH values were categorized into two groups, acidic and basic. This analysis showed a moderately strong association between lead concentrations and pH (Cramer's V = 0.472). There is a moderate negative correlation between pH and lead content (r = -0.369), showing that as pH decreases, lead content increases.

**Table 6. Lead content by pH (n=195).**

| Lead in Water | pH below 7 (acidic) | pH above 7 (basic) |
|---|---|---|
| No Lead | 8.3 | 39.9 |
| 0.0001 to 1.000 | 25.0 | 45.4 |
| 1.0001 to 4.9999 | 25.0 | 12.6 |
| 5.0000 and Higher | 42.7 | 2.2 |
| Total | 100.0<br>(n=12) | 100.0<br>(n=183) |
| Cramer's V | 0.472 | |

As mentioned in the literature review, age of housing correlates with lead exposure. Respondents to the survey were grouped by age of housing, both by the year they reported (if they knew their age of housing) as well as by median age of housing in their census tracts. **Table 7** shows these data for the age of housing reported by participants, while **Table 8** shows these data for median age of housing based on census tracts. These data show that of those who reported their age of housing as being built before 1986, 60% were found to have lead in their water. The numbers are similar for the median age of housing, which incorporates that household's particular census tract. For those whose median age of housing is before 1986, just fewer than 60% of households had lead content in their water. The Cramer's V value for **Table 7** is 0.124, demonstrating a moderate association between lead levels and age of housing. For **Table 8**, the value is 0.256, which also shows a moderate association between median age of housing and lead concentration. The patterns in Tables 7 and 8 differ, however, showing that the association between median age of housing and lead is stronger than that of reported age of housing and lead.

**Table 7. Lead content by reported age of housing (n = 101).**

| Lead in Water | Housing Built Before 1986 | Housing Built 1986 or After |
|---|---|---|
| No Lead | 40.9 | 31.6 |
| 0.0001 to 0.0500 | 38.6 | 50.9 |
| 1.0001 to 4.9999 | 13.6 | 12.3 |
| 5.0000 and Higher | 6.8 | 5.3 |
| Total | 100.0<br>(n=44) | 100.0<br>(n=57) |
| Cramer's V | 0.124 | |

**Table 8. Lead content by median year housing was built (n = 195)**

| Lead in Water | Housing Built Before 1986 | Housing Built 1986 or After |
|---|---|---|
| No Lead | 42.8 | 10.3 |
| 0.0001 to 1.0000 | 40.4 | 65.5 |
| 1.0001 to 4.9999 | 13.3 | 13.8 |
| 5.0000 and Higher | 3.6 | 10.3 |
| Total | 100.0<br>(n=166) | 100.0<br>(n=29) |
| Cramer's V | 0.256 | |

The data were also analyzed for lead content based on housing type, and housing tenure. Using data for housing type and tenure, we are able to see the frequency of each type of home that was found to have lead in their water. **Table 9** and **Table 10** detail the results of these cross tabulations. For **Table 9**, the value of Cramer's V is 0.157, signifying that there is a moderate association between lead content in water and housing type. This value is 0.154 for **Table 10**, showing that the association is also moderate for lead content versus housing tenure. These data show that those living in mobile homes and apartments had higher percentages of detectable lead than houses. The data also show that those who own their houses have higher rates of detectable lead concentrations than those who rent their home or have some other arrangement.

**Table 9. Lead content based on housing type (n=193).**

| **Lead in Water** | **House** | **Mobile Home** | **Apartment/Other** |
|---|---|---|---|
| No Lead | 42.5 | 18.2 | 32.0 |
| 0.0001 to 1.0000 | 37.7 | 68.2 | 60.0 |
| 1.0001 to 4.9999 | 14.4 | 13.6 | 4.0 |
| 5.0000 and Higher | 5.5 | 0.0 | 4.0 |
| Total | 100<br>(n=146) | 100<br>(n=22) | 100<br>(n=25) |
| Cramer's V | | 0.157 | |

**Table 10. Results of lead content based on housing tenure (n=189).**

| **Lead in Water** | **Rent (%)** | **Own (%)** | **Other (%)** |
|---|---|---|---|
| No Lead | 42.6 | 38.9 | 22.2 |
| 0.0001 to 1.0000 | 50.0 | 38.1 | 66.7 |
| 1.0001 to 4.9999 | 5.6 | 16.7 | 11.1 |
| 5.0000 and Higher | 1.9 | 6.3 | 0.0 |
| Total | 100<br>(n=54) | 100<br>(n=126) | 100<br>(n=9) |
| Cramer's V | | 0.154 | |

In order to visually represent the values of lead content versus reported age of housing, **Figure 1** was created to display those homes with a detectable lead concentration ($r = -0.183$). Two outliers have been marked in this figure. When the first was removed the correlation remained the same (r = -0.183). When the second outlier was removed, however, the correlation changed from a weak negative correlation to a moderate negative correlation (r = -0.370). **Figure 2** was created to identify any patterns or correlations for households who had detectable lead levels (r = 0.124). This figure shows a positive trend between median age of housing and lead concentration. Two outliers have been marked on this figure. Upon removing the first outlier, the correlation becomes a weaker positive correlation (r = 0.079). With the removal of the second outlier, the correlation becomes an even weaker positive correlation (r = 0.026).

**Figure 1. Scatter plot of all households who reported the year built except those who had no detectable lead levels (n=47).**

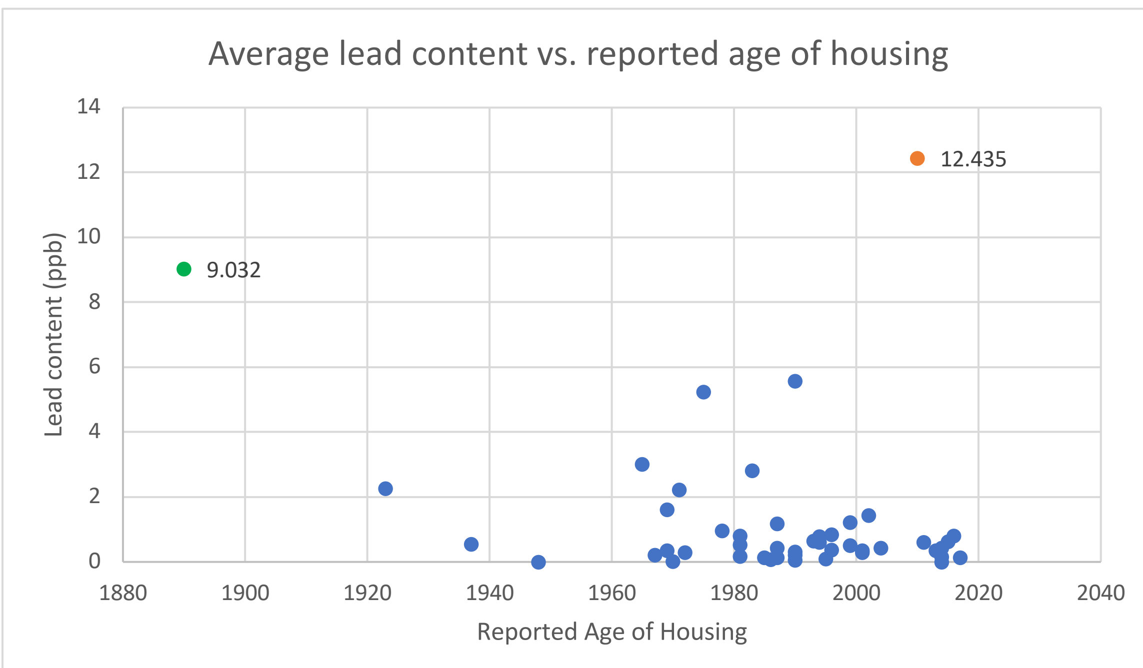
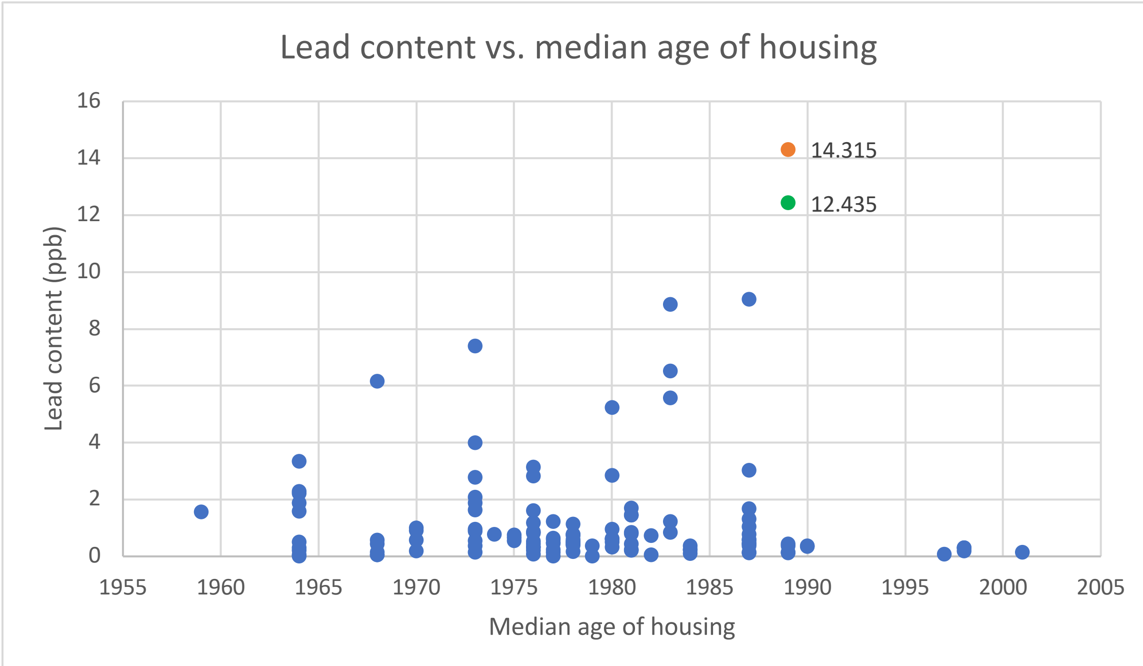


**Figure 2. Scatter plot of households with detectable lead content by median age of housing (n=121).**



# DISCUSSION

One of the questions that this project sought to answer was whether outreach and community engagement methods could be used to collect data and identify areas and communities that were at higher risk for lead (or any number of public health issues). These results, which both inform and contradict the literature that exists, can be used to answer this question. From the existing literature, we know that the groups most affected by lead exposure are those groups that are traditionally affected at disproportionate rates by health disparities. Existing studies and sampling patterns show that risk of lead exposure is significantly higher for minority groups (Muennig, 2009). This is substantiated by the data from this project, though it is not a clear-cut result. In this case, the data show that white households have a disproportionate rate of lead exposure, with 86% of white households having detectable lead levels, compared with 56% of non-white households. While there were more white-households in these data that were affected by lead, there were still a significant number of non-white households who were exposed also. It is important to note, however, that the majority of households who received their water from a well were white (78%). This is significant because wells had higher rates of lead when compared to public water systems (85% versus 57%). Because private wells are not subject to random sampling by government agencies, this means that they could be traditionally excluded from the data, leaving well-owners at an unchecked risk for lead exposure.

Because an acidic pH is known to cause lead to leach into drinking water from lead pipes, solder, or service lines (Kim et al., 2011), we analyzed the relationship between pH and lead concentration. The results from this analysis showed that those households with more acidic pH's were more likely to have lead in their water (92%, n = 12). Because pH is not the only determining factor for lead contamination in drinking water, it is important not to rely solely on pH measurements for lead concentrations. While it can be a contributing factor, there were also several households (60.1%, n = 183) who did not have an acidic pH but still had detectable lead concentrations. While using areas with consistently acidic pH's could be a useful tool for pinpointing at risk areas, it does not target all areas or households who could be at risk for lead exposure.

Within these data, a correlation can also be identified between lead and age of housing. **Figure 1**, which includes all outliers and households that had detectable levels of lead, shows there is a moderate to weak correlation between age of housing and lead concentration. However, by using **Figure 3** (r = -0.095) which has two outliers removed, we see that there is very little correlation between median age of housing and lead content. While these samples were not randomized (therefore they cannot be used to make generalized statement for a larger population) this trend demonstrates that older housing correlates with lead concentration. This negative correlation shows that as age of housing increases, lead content decreases, a data point that could be used to pinpoint at-risk areas for future sampling and outreach and inform pre-existing sampling methods. The literature also shows that those who live in older housing, specifically housing built before 1986, were at higher risk for lead exposure (Bernard & McGeehin, 2003). For both reported age of housing and median age of housing (based on census tracts) over 60% of households sampled built before 1986 have detectable concentrations of lead in their drinking water. When compared by median age of housing, however, the data showed a positive correlation, even with outliers removed (**Figures 4, 5, 6**).

These data, however, could be used to inform testing and monitoring by using these trends (as well as trends in other studies) to pinpoint at risk areas for testing. For example, in an area where there is traditionally older housing as well as households who rely on well water, these data and trends could be used to identify this area as a higher-risk location. By focusing on this area, officials who enforce the *Safe Drinking Water Act* and the *Lead and Copper Rule* would be able to use these data in order to find at-risk areas that have been shown to have disproportionate rates of lead exposure for continued testing and mitigation. These data, or data collected in similar projects, could be used to help inform monitoring and outreach for lead exposure, or other public health issues. These data could also help to inform government intervention and testing in order to minimize this risk. This project, however, was much more than an assessment of quantitative survey data; it also sought to assess the quality of community-based research methods as a means of involving communities in their own education and betterment of a public health issue.

By using methods of community engagement and community-based research, we were able to expand a project that focused on the improvement of a public health issue into the communities most affected by that problem. Lead in drinking water is a serious threat to public health, but by engaging community members in the research and including them as participants, not merely research subjects, this project offered the opportunity for them to engage and discuss the issue of lead themselves. Through internal analysis and cost effectiveness, we found that different methods of outreach, education, and community interaction yielded better results for return, cost effectiveness, and community engagement.

While each workshop had individual strengths, there were some common assets that the overall project helped to promote. By working with community partners, we were able to foster pre-existing relationships with community leaders, helping to build a strong foundation for not only the project, but also for outreach and researcher-participant trust. One important strength is that this project not only engaged community organizations in the research, it also engaged families, students, and members of the community that were able to learn more about the dangers of lead. A major strength of this project is that each individual household, after participating in an event, received a letter detailing the results of their sample, how to minimize risk of exposure, and in some cases, a certified filter for removing lead. Several workshops primarily involved students and their families. It is important to note that these students, who are part of either pre-health professions group or a school health council, were a part of an organization with a community partner who promotes a culture of accountability within these students and their organization. It could be for this reason that these workshops had some of the highest return rates in the project.

We hypothesized that those groups that had higher rates of engagement would have higher return rates. Those groups with the highest rates of engagement had higher return rates. For example, Community Engagement Event E had great rates of engagement based on the internal survey and also had a 100% return rate for bottles. Another example was Community Engagement Event G. Through the internal survey, it was shown that this event had some of the highest engagement rates of the entire project. They also had one of the highest rates of return, despite concern that bottles would not be returned as they were distributed to minors.

Each workshop was also analyzed for cost effectiveness. This allowed for us to determine the efficiency of each workshop both in total and per bottle. While the costs per bottle varied for each workshop, it showed that certain methods of workshops were more expensive per bottle. For example, Events H and I were found to have relatively expensive costs per bottle. These events were those that were full day workshops for multiple days. These were costlier for personnel time when compared to those workshops that were only two hours. The cost effectiveness was also analyzed when costs of travel were removed.

Because some workshops were significantly farther away than others, this analysis allowed us to normalize costs to compare individual workshops.

When it came time for bottle collection, the return rates were within the expected range for many of these events. In previous studies of "drop off/pick up" (DOPU) surveys, return rates have varied from 33% to 79%, with an average of 63.2% (Dolan, Trentelman, Holyoak, Thomas, & Ma, 2016). The average return rate for our bottles was just above 66% (**Table 1**). This project operated under similar methods, but the methods employed were rather unique. Instead of dropping off a survey and picking it up later, participants were given a survey and a bottle and were asked to drop the bottles off themselves. This is similar to DOPU surveys in that participants were not monitored during their participation and were given their own time to participate. DOPU surveys have produced better return rates than mail surveys and still provides the face-to-face interaction necessary for community-based research (Trentelman, Irwin, Petersen, Ruiz, & Szalay, 2016). Because our project falls within the range that other similar methods have produced, we know that our project has many strengths that have made these workshops—and this project—successful.

These strengths allowed us to facilitate workshops in which community members were themselves participating in the research. By allowing them to sample their own water, they were given some control over the project. One of the strongest aspects of this project was the fact that each household received their individualized results after testing. They were also sent an informational flyer that reiterated what they had already learned (in most cases) from the workshops. It detailed the dangers of lead exposure as well as ways to minimize the risk of exposure. In some cases, (n = 9) participants lead exposure was above 5 ppb, which prompted our team to send them a filter that removes lead. Many participants were thoroughly engaged in the workshops and seemed to learn a lot. They asked questions and helped to lead discussions, though they were not a community partner or team member. This helped to solidify the idea that the workshops were collaborative and engaging.

This project was not without challenges, however. One of the major challenges we faced at each workshop was the engagement of participants. It was relatively hard to have participants fully engaged and attentive to the workshop, whether it be distractions, unclear instructions of time frames, or some other reason. Because engagement and investment are key components of CBR, it is crucial that participants are participating, not observing. We faced much of this with regards to the clinics. Because participants did not approach us, but rather were approached, they were less attentive, less engaged, and less willing to return the bottles (each clinic had lower return rates than all of the other workshops and a lower return rate than the average). The samples that were returned were not monitored during collection, so whether or not participants followed sampling instructions cannot be determined. An unforeseen challenge we faced was the actual return of individual results. There were many returned envelopes that could not be delivered (n = 23), meaning that several households did not receive their results. Another challenge that we faced was that many of the workshops, because of a lack of participation or attendance, fell back into the traditional research dynamic between researcher and subject. In order to keep from establishing this dynamic, it is important that researchers (and participants) are well aware of the roles of the other and actively seek to engage with one another on a level that allows each to have some form of control. One challenge that we also faced was that there was no follow-up with participants after they received their letter. In an attempt to maintain confidentiality in the survey and water sampling, no names or personal information were collected from the participants. The only means of communication with participants is through the mailing address. Without follow-up, we cannot truly know how effective the return of the content is, and whether or not participants actually benefitted from their results report. However, reaching out to individual participants could remove anonymity and could cost participants their personal privacy about their results or their decision on how they act toward the results.

There were many inconsistencies that were unintentional on the part of the team. Though each of the workshops intentionally used different methods, some of the workshops were somewhat disorganized and did not employ the intended methods. It was also difficult to figure out who would be attending events, as many of the events were far away and each team member had different conflicting schedules and obligations. Given the large team involved in this complex project, it was also difficult to keep track of who had attended each meeting, who had entered data for each collection, and a host of other difficulties. Though it engages community members in the research, CBR is costly and time consuming; requiring time, money, and resources. But in comparison with how much money the state and the country lose because of lead exposure (Reyes, 2007), the cost is relatively insignificant. This applies to many other public health issues, not just lead.

For those Mississippi residents who wish to have their water tested, there are options outside of this project. The Mississippi Department of Health (MDOH) has an option that allows residents to request a sampling kit for a private residence. The kit costs $20 and upon request can be sent to the participant's home. They sample the water themselves and then have the option to mail back the sample or drop it off at the lab where it will be analyzed. Typically, results are returned to participants in less than two weeks. According to the MDOH, in a typical year they sample less than 100 samples. However, because of the recent crises with lead and copper contamination in the City of Jackson, this number has dramatically increased to a few thousand a year. This number, however, is on the decline as water conditions are thought to return to normal. In the two years since this project began, we have tested 195 samples. While this is near the range of a typical year for MDOH, it is much less than that of the last years since the led crisis in Jackson, MS. These workshops, however, provide participants with the opportunity to learn about lead in an engaging and open setting. The workshops are also presented to them by a trusted community partner and they do not have to seek testing out. It is difficult to find information about private testing without calling MDOH. This could make it difficult for those wanting to have their water tested if they do not know where to find the information.

*Recommendations*

Because several departments in completely different parts of the university collaborated on this project, it is difficult to find a balance between the three fields, which vary wildly between expectations for research. Though each informs the other, it is difficult to determine whose role is what in the project. In order to decide these components of the project, monthly meetings to address concerns, updates, and keep everyone updated would be beneficial to the project and every member of the team. Because of setbacks involving data entry, bottle collection, and event attendance, it would also be useful to set dates for each collection event ahead of time. Rather than planning an event for one month before hand, have the dates pre-chosen and sent to team members so that they can have time to plan and move other obligations around to accommodate those times. This could, however, detract from the organic development of community engagement. Though it would be useful to the team, it could cause the project to become a traditional research project where researchers decide all of the details, and participants are asked to participate with no inclusion in major decisions. It is also important to make sure that not only participants are fully invested, but also team members. It can be difficult, especially during the school year, for students and faculty and staff to be fully engaged with the project, but by finding team members who are truly interested in the project and its success would be extremely beneficial.

We also know that as this project continues, it is a learning process. As we test different methods and employ different strategies of engagement, we are able to understand what works and what does not. Moving forward, the project can improve and help to reach more people and allow more people to have their water tested. This project has the potential to influence health and policy across the state. By allowing community members to become a part of the testing and monitoring of their own drinking water, government officials can use these types of projects, workshops, and events to improve their own testing and monitoring methods. Before this can happen, it is important to expand this project from where it is now. By using our own recommendations of using the data to pinpoint at-risk areas, we can target at-risk areas by marketing workshops within those areas by means of a community partner.

This project can have bigger implications as well for CBR methods, not just lead testing. Because it focused on a major public health issue, this project was able to create an atmosphere of learning and inclusion for community members, something that CBR aims to do with all research projects. It can also help to inform other forms of research where materials are sent home with participants and collected later. By allowing the methods that worked best for us to influence other similar projects, the organizations that employ them can improve their own understanding of CBR.

# CONCLUSION

Our project aimed to create an atmosphere of community and inclusion in order to inform and influence a major public health issue—lead in drinking water. By using a mixture of CBR methods to do outreach and testing, we were able to join forces with community partners in order to set up a workshop that would facilitate this environment. Though each workshop was structured slightly differently and employed different methods of CBR, the project, as a whole, used commonalities of this type of research to engage and expand this project in order to allow communities to come together, discuss, and participate in the improvement of the risk of lead in drinking water. While many of the methods we tried did not work as effectively as we would have hoped, we found many more that did and that helped to build a solid foundation for CBR and for this project to continue into the future. By using both qualitative and quantitative data collection and analysis procedures, we were able to analyze whether each individual workshop succeeded in engagement, quality, and cost effectiveness across the project. These analyses provided us with a system of understanding strengths, challenges, opportunities and weaknesses for forward progress and future expansion of the project.

## LIST OF REFERENCES


Abelsohn, A. R., & Sanborn, M. (2010). Lead and children: Clinical management for family physicians. *Clinical Review: Environment and Health Series, 56*, 531-535.

Albah, E., Carroll, J., & Bronleewe, T. (2016). A Community-Based Participatory Research Approach to Identifying Environmental Concerns. *Journal of Environmental Health, 79*(5), 14-19.

American Association for the Advancement of Science. (2018, July 11). *Lead in U.S. drinking water*. Retrieved from SciLine: www.sciline.org/evidence-blog/lead-drinking-water

American Public Health Association. (2018). *What is Public Health?* Retrieved from APHA: https://apha.org/what-is-public-health

Andrews, J., Newman, S., Cox, M., Bunting, S., & Meadows, O. (2012). Partnership readiness for community-based participatory research. *Health Education Research, 27*(4), 555-571.

Bellinger, D. (2008). Neurological and behavioral consequences of childhood lead exposure. *PLOS Medicine, 5*(5), e115.

Bernard, S., & McGeehin, M. A. (2003). Prevalence of blood lead levels ≥5 ug/dL among US children 1-5 years of age and socioeconomic and demographic factors associated with blood lead levels 5-10 ug/dL, third national health and nutrition examination survey, 1988-1994. *Pediatrics, 112*(6), 1308-1313.

Brown, M. J., & Margolis, S. (2012). Lead in drinking water and human blood lead levels in the United States. *61*, 1-9.

Burns, J. C., Cooke, D. Y., & Schweilder, C. (2011). *A Short Guide to Community-Based Participatory Action Research.* Advancement Project - Healthy City.

Centers for Disease Control and Prevention. (2015, December 8). *Lead: Pregnant Women*. Retrieved from Centers for Disease Control and Prevention: https://www.cdc.gov/nceh/lead/tips/pregnant.htm

Centers for Disease Control and Prevention. (2018, July 18). *Lead*. Retrieved from Centers for Disease Control and Prevention: https://www.cdc.gov/nceh/lead/default.htm

Citizen Science Association. (2018). *What is Citizen Science?* Retrieved from Citizen Science Association: www.citizenscience.org

Dolan, M., Trentelman, C. K., Holyoak, G., Thomas, B., & Ma, G. (2016). Effectiveness of the Drop-Off/Pick-Up Survey Methodology in Different Neighborhood Types. *Journal of Rural Social Sciences*, 35-67.

Environmental Protection Agency. (2017, March 15). *Lead and Copper Rule*. Retrieved from United States Environmental Protection Agency: https://www.epa.gov/dwreginfo/lead-and-copper-rule

Environmental Protection Agency. (2017, January 12). *Safe Drinking Water Act (SDWA)*. Retrieved from United States Environmental Protection Agency: https://www.epa.gov/sdwa

Environmental Protection Agency. (2018, March 23). *Basic Information about Lead in Drinking Water*. Retrieved from Environmental Protection Agency: https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water

Environmental Protection Agency. (2018, August 20). *Learn about Lead*. Retrieved from Environmental Protection Agency: https://www.epa.gov/lead/learn-about-lead#lead

Fowler, T. (2008, October 21). *A Brief History of Lead Regulation*. Retrieved from Science Progress: https://scienceprogress.org/2008/10/a-brief-history-of-lead-regulation/

Gould, E. (2009). Childhood Lead Poisoning: Conservative Estimates of the Social Economic Benefits of Lead Hazard Control. *Environmental Health Perspectives*, 1162-1167.
Hacker, K. (2013). *Community-Based Participatory Research.* Los Angeles: Sage.
Halseth, G., Markey, S., Ryser, L., & Manson, D. (2016). *Doing Community-Based Research: Perspectives from the Field.* Montreal: McGill-Queen's University Press.
Holland, J. (2013). *Who Counts?: The power of participatory statistics.* Rugby: Practical Action Publishing.
Jones, L., Koegel, P., & Wells, K. B. (2008). Bringing Experimental Design to Community-Partnered Participatory Research. In M. Minkler, & N. Wallerstein, *Community-Based Participatory Research for Health: From Process to Outcomes* (pp. 67-90). San Francisco: John Wiley & Sons, Publishers.
Kim, E. J., Herrera, J. E., Huggins, D., Braam, J., & Koshowski, S. (2011). Effect of pH on the concentrations of lead and trace contaminants in drinking water: A combined batch, pipe loop and sentinel home study. *Water Research*, 2763-2774.
Lanphear, B. P. (2005). Childhood Lead Poisoning Prevention: Too Little, Too Late. *Journal of the American Medical Association*, 2274-2276.
Levin, R., Brown, M., Michael, K. E., Jacobs, D. E., Whelan, E. A., Rodman, J., . . . Sinks, T. (2008). Lead Exposures in U.S. Children, 2008: Implications for Prevention. *Environmental Health Perspectives*, 1285-1293.
Liu, J., Liu, X., Wang, W., McCauley, L., Pinto-Martin, J., Wang, Y., . . . Rogan, W. J. (2014). Blood Lead Levels and Children's Behavioral and Emotional Problems: A Cohort Study. *Journal of the American Medical Association: Pediatrics*, 737-745.
Luckerson, V. (2016, February 24). *Jackson, Miss. Cautions Against Drinking Tap Water After Lead Reports*. Retrieved from TIME: http://time.com/4235777/jackson-mississippi-lead-drinking-water/
Mississippi State Department of Health. (2017, May 16). *Lead and Jackson Water: Recommendations for Homeowners, Schools, and Facilities*. Retrieved from Mississippi State Department of Health: https://msdh.ms.gov/msdhsite/_static/23,0,195,720.html
Muennig, P. (2009). The Social Costs of Childhood Lead Exposure in the Post-Lead Regulation Era. *Journal of the American Medical Association: Pediatrics*, 844-849.
Reyes, J. W. (2007). *Environmental Policy as Social Policy? The Impact of Childhood Lead Exposure on Crime.* Cambridge, MA: National Bureau of Economic Research.
Sanborn, M. D., Abelsohn, A., Campbell, M., & Weir, E. (2002). Identifying and managing adverse environmental health effects: 3. Lead exposure. *Canadian Medical Association*, 1287-1292.
Schneider, J. D., & Lavenhar, M. A. (1986). Lead Poisoning: More than a Medical Problem. *American Journal of Public Health*, 242-245.
Showalter-Otts, S., & Janasie, C. (2017). *How Safe is the Water?: An Analysis of the Lead Contamination Risks of Public Water Supplies in the Mississippi Delta.* University, MS: National Sea Grant Law Center, University of Mississippi.
Stoecker, R. (2005). *Research methods for community change: A project-based approach.* Thousand Oaks, California: Sage Publications.
The Associated Press. (2017, June 14). *A timeline of the water crisis in Flint, Michigan*. Retrieved from Assocated Press News: https://www.apnews.com/1176657a4b0d468c8f35ddbb07f12bec

The Associated Press. (2018, July 19). *With Acid Problems, Jackson Renews Drinking Water Warnings*. Retrieved from Jackson Free Press: http://www.jacksonfreepress.com/news/2018/jul/19/acid-problems-jackson-renews-drinking-water-warnin/

Trentelman, C., Irwin, J., Petersen, K. A., Ruiz, N., & Szalay, C. S. (2016). The Case for Personal Interaction: Drop-Off/Pick-Up Methodology for Survey Research. *Journal of Rural Social Sciences*, 68-104.

United States Census Bureau. (2016). *American Community Suvey.* Retrieved from US Census: http://www.census.gov/programs-surveys/acs

US Census. (2016). *United States Census Bureau.* Retrieved from American Fact Finder: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml?

Weisman, M. (2012, February 13). *Sonoma State University*. Retrieved from cce.sonoma.edu/blog/what-community-based-participatory-research

**APPENDIX**

## Mississippi Drinking Water Survey

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We are conducting this survey as part of the "Reducing Lead Levels in Mississippi Drinking Water" project in partnership between the Tri-County Workforce Alliance and the University of Mississippi National Sea Grant Law Center, Environmental Toxicology Program, and Center for Population Studies. This information will be connected with your tap water sample to better understand the factors associated with housing, water quality, and health. You will need help from your parents/guardians in completing this form. Participation is completely voluntary, and you may refuse to answer any question for any reason. While we are asking for your address, note that we will not release your individual address with any public presentations from this research. Instead, we will use the address to identify the location of the housing unit to better understand the water system.

This study has been reviewed by the University of Mississippi's Institutional Review Board (IRB). If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

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***HOUSING*** *– To start, we would like to know about your housing.*

1. What is your physical address (no PO Boxes)? (*Please make sure that this matches the address you provide with the water sample.*)

    Number: ___________________, Apt. or Lot Number (if applicable): ____________

    Street: ____________________________________________________________

    City: ____________________________________________________________

    Zip: _____________________

2. Do you currently live in a house, mobile home, or apartment?
    [ ] House [ ] Mobile home [ ] Apartment [ ] Other, please specify

3. Does someone in your household rent or own this residence? [ ] Rent [ ] Own [ ] Other, please specify

4. Do you know what year this residence was built/manufactured? [ ] Yes [ ] No

    a. If yes, please list the year __________

    b. To the best of your knowledge, have the pipes in this residence ever been replaced?
        [ ] Yes [ ] No [ ] Unsure

        i. If yes, please list the year __________

5. Does this residence have… ? (check all that apply)
    [ ] running/tap water [ ] hot tap water [ ] one or more sinks with faucets [ ] one or more bathtubs/showers

6. If the residence has running/tap water, what is the water used for? (check all that apply)
    [ ] drinking [ ] cooking [ ] bathing [ ] cleaning [ ] recreation [ ] gardening

7. If the residence has running/tap water, is there a filter for…? (check all that apply)

[ ] drinking water [ ] ice cubes [ ] Other, please specify

8. Where does the water for this residence come from?
[ ] Public water system (city, water association, etc.) [ ] Private well [ ] Other, please specify

a. If the water comes from a public water system, please provide the name of the utility here.
b. If the water comes from a public water system, has anyone in the household received an annual water quality report from the utility in the past 24 months?
[ ] Yes [ ] No

***HEALTH** – Please answer the following questions about your health and access to health care.*

9. Has there been a time in the past 12 months when someone in the household needed to see a health care provider but could not, because of cost?
[ ] Yes [ ] No

10. Has anyone in the household been checked for blood lead levels while <u>living in this residence</u>?
[ ] Yes [ ] No

a. If yes, when, at what age, and what was the outcome? (If more than 5, please add on a separate sheet of paper)

| Person # | Year of Test | Age when Tested | Diagnosed with Elevated Lead Levels in Blood? |
|---|---|---|---|
| 1 | | | [ ] Yes [ ] No |
| 2 | | | [ ] Yes [ ] No |
| 3 | | | [ ] Yes [ ] No |
| 4 | | | [ ] Yes [ ] No |
| 5 | | | [ ] Yes [ ] No |

11. Has anyone in the household given birth in the past 12 months? [ ] Yes [ ] No

If yes, is the baby being…? (check all that apply) [ ] Breastfed [ ] Formula fed [ ] Eating solid foods

***SOCIODEMOGRAPHIC CHARACTERISTICS** – As the final set of questions, we would like to ask about your household characteristics.*

12. How many people live in this residence, and what is their age, sex, and race/ethnicity? (If more than 10, please add on a separate sheet of paper)

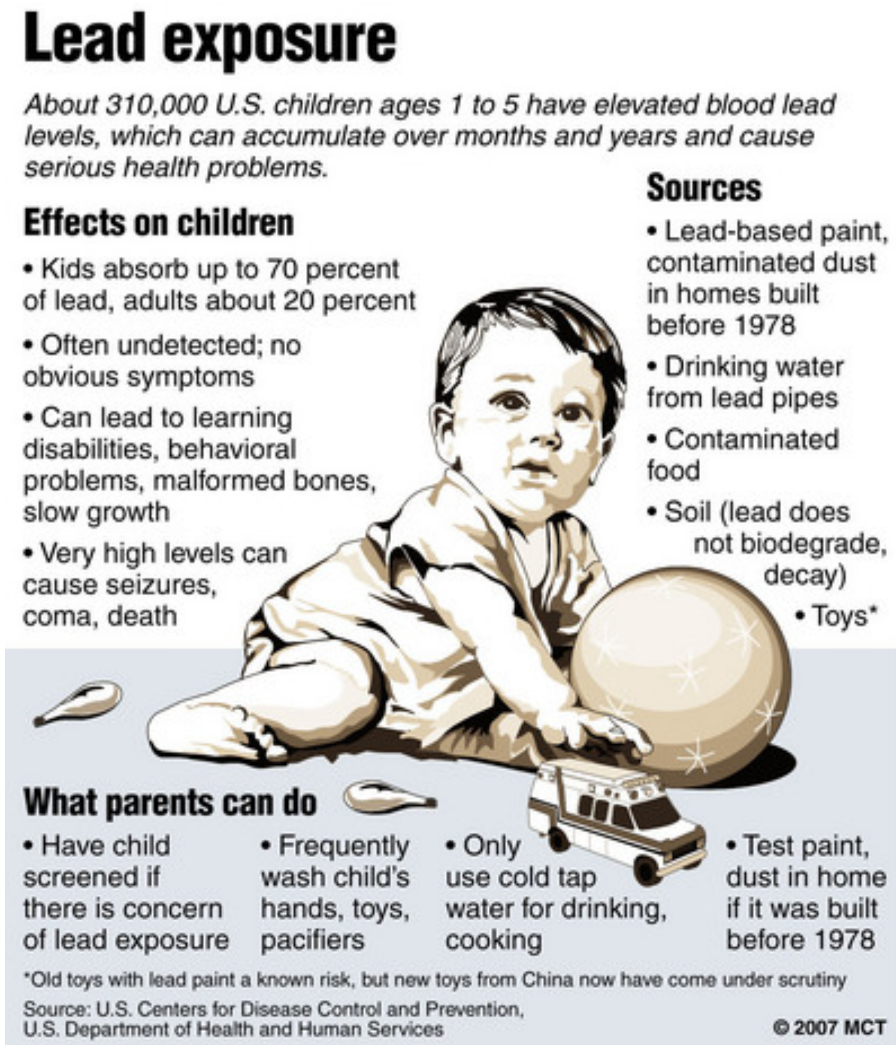
| Person # | Age (in years) | Sex (Male, Female) | Race (White, Black/African American, Asian, American Indian or Native Alaskan, Hawaiian or Pacific Islander) | Hispanic/Latino (Yes or No) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |

13. What was the **total household income**, before taxes were taken out, in 2015?

[ ]Less than $10,000 [ ]$30,000 - $39,999 [ ]$60,000 - $69,999 [ ]$90,000 - $99,999
[ ]$10,000 - $19,999 [ ]$40,000 - $49,999 [ ]$70,000 - $79,999 [ ]$100,000 or More
[ ]$20,000 - $29,999 [ ]$50,000 - $59,999 [ ]$80,000 - $89,999

***Thank you for taking the time to complete this questionnaire. Please return it with your water sample.***

MS




**Department of Health – Lead Poisoning Prevention and Healthy Homes Program**
**From Fact Sheet – Feb. 2016**

**Prevention Tips**

- Teach children to wash their hands after playing outside and before meals.
- Discourage children from eating things that fall on the ground and placing non-food items in the mouth.
- Wash bottles, toys and pacifiers often.
- Don't let children eat loose pieces of paint or chew on painted surfaces.
- Give your child something healthy to eat every 2-3 hours to reduce lead absorption.
    - A healthy diet is high in iron, protein, vitamin C and calcium and low in fat and oil.
- If you suspect lead in your water,
    - According to the Environmental Protection Agency, let the water run for 30 seconds to 2 minutes before drinking or cooking.
    - Use a home water filter (such as PUR) to remove lead from the water before drinking or cooking.
    - Use bottled water or nursery water for making baby formula and juices.
    - During bath time, do not let small children get water in their mouth.

More info at Centers of Disease Control: http://www.cdc.gov/nceh/lead/tips.htm

**Mississippi State Department of Health Lead Poisoning Prevention and Healthy Homes Program Fact Sheet** *February 2016*

**Program Goal:** Promote statewide efforts to eliminate lead poisoning in children less than 72 months of age, and promote the development of strategies to decrease housing-related environmental hazards (i.e., mold, mildew, carbon monoxide, smoke, and pests) that may contribute to undesirable health conditions.

**Who is Tested?**

The state of Mississippi does targeted screening of Medicaid-enrolled or Medicaid-eligible children ages 6-72 months of age through the Cool Kids Early and Periodic Screening Diagnosis and Treatment (EPSDT) program. Medicaid recipients or Medicaid-eligible children are routinely screened at 12 and 24 months and at any time risk factors are identified through the Blood Lead Screening and Healthy Homes Summary.

**Reference Value for Lead Poisoning**

The Centers for Disease Control and Prevention has set the Reference Value for lead poisoning at ≥5µg/dL. Any child with a venous blood lead level of ≥5µg/dL that is reported to the Mississippi State Department of Health's Lead Poisoning Prevention and Healthy Homes Program receives the following services:

| Blood Lead Level | Services Provided |
|---|---|
| 5-14 µg/dL | Educational Counseling |
| ≥15 µg/dL | Home visit and environmental assessment |

To learn more about the risks of lead or to arrange a lead screening, contact your primary care provider or call the Mississippi Lead Poisoning Prevention and Healthy Homes Program at **(601) 576-7447**.