Public Perceptions of Lead in the United States: Exploring Perceived Risk, Trust, and Subjective Knowledge

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Abstract

Lead exposure remains a pertinent public health issue in the United States (U.S.) despite multiple policies and regulations to control sources of lead in the environment. Existing social science research on human interactions with lead has primarily focused on at-risk population groups and areas with high levels of contamination. As such, little is known about perceptions of lead for a cross-section of the public, which can contribute to improved health protective remediation and messaging. This research contributes to a broader understanding of public perceptions of lead in the U.S. using data from a national online survey of U.S. residents (n = 1,035). In the first chapter, I 1) compare the perceived risk of lead exposure to other common environmental risks and 2) explore the relationships between trust in government management of lead, subjective knowledge about lead, and the perceived risk of lead exposure. Results reveal that lead exposure is perceived to be less risky than air pollution, pollution of rivers and lakes, climate change, and habitat loss. Our regression analyses indicate that both trust in government management of lead and subjective knowledge about lead significantly and positively predict perceptions of lead exposure risk. When considering the potentially moderating effect of subjective knowledge, I found evidence contradicting past findings that trust is a stronger predictor of perceived risk when knowledge is low. In the second chapter, I further investigate trust in government management of lead as a function of reliance and skepticism. Reliance is defined as the general trustworthiness of a risk management entity. Skepticism refers to the existence of any doubtful views regarding the risk management entity and how risk policies are enacted. We first categorize respondents into four different groups related to their level of trust in government management of lead – rejection, distrust, critical trust, and acceptance – based on levels of reliance and skepticism. We then examine predictors of group membership using sociodemographic, environmental, and other variables including trust in scientists and subjective knowledge. Findings indicate that a majority of respondents demonstrate high levels of skepticism in government management of lead. I discuss implications for results from Chapters 1 and 2 in the broader context of lead risk management in the U.S and opportunities for future research.

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Dedication

This thesis is dedicated to my grandfather, Frank Goebel, and my most loyal friend, an English Springer Spaniel named Lizzie. May you both rest in peace.

There are many people who have helped me through the last two years. First and foremost, thank you to my family – Mom, Dad, Emma, and Peter – for supporting me tirelessly from start to finish. I have cherished our weekly family dinners and weekend breaks on the farm. Next, I thank Courtney Cooper and Katie Wollstein. You both have been integral to my success in graduate school in so many ways. I treasure your guidance, and more importantly, your friendships. Thank you for being there for all the tears and all the laughs. Many others, near and far, have offered me respite from the stress of graduate school – Maggie, Bridget, Katie S., Natalie, Eliza, Grace, and more. To Mackenzie, Tara, and Kris – thank you for always treating me like a member of your family and reminding me not to take everything too seriously. Lastly, I would like to thank Noah for his never-ending kindness and support. You have been my biggest cheerleader and I am forever thankful.

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Statement of Contribution

Dr. Chloe Wardropper was involved in all steps of the research process, from project inception to editing of the overall thesis. Dr. Alan Kolok and Dr. Dilshani Sarathchandra edited the overall thesis as well. Dr. Dilshani Sarathchandra was also involved in survey development, offered guidance on statistical analysis, and provided an additional round of edits on Chapter 1.

Chapter 1: Introduction

Lead is a naturally occurring metal that has infiltrated human environments due to anthropogenic activities such as mining and manufacturing. Lead is a dangerous neurotoxin understood to be hazardous to human health. Lead exposure is associated with a host of negative health outcomes including damage to the central nervous system, learning difficulties, and behavioral changes (Vorvolakos et al., 2016). Children and pregnant women are especially vulnerable to these health effects, particularly among low-income and minority populations (Schnur & John, 2014). Acceptable blood lead levels have decreased over time as research demonstrates that even small quantities of lead in the body can negatively impact health (Järup, 2003). In fact, the Center for Disease Control (CDC) concluded in 2012 that there is no safe level of lead exposure in children (Vorvolakos et al., 2016). To help manage lead, Congress has passed several laws to manage lead in the environment, most administered by the Environmental Protection Agency (EPA). For example, the Lead and Copper Rule (LCR) is designed to identify lead contamination in tap water and requires proper mitigation measures when high levels of lead are found in consumer water sources (Katner et al., 2016). Perhaps a more well-known example includes the phasing out of lead from gasoline, based upon public health regulations in the Clean Air Act (Bridbord & Hanson, 2009).

Despite regulatory efforts to manage existing and prevent future lead contamination, exposure to lead remains a persistent concern (Järup, 2003). For example, lead exposure from drinking water has increased, despite both fewer exposures from food, paint, soil, and dust, and a decrease in average national blood lead levels (Katner et al., 2016; Pirkle et al., 1994; Raymond, 2017). The American Water Works Association estimates that between 15 and 22 million citizens receive water from leaded water infrastructure (Cornwell et al., 2016). Residents of mining-impacted communities also remain at risk due to their proximity to industrial facilities or legacy contamination (Entwistle et al., 2019). Moreover, there have been high-profile lead exposure crises in the twenty-first century, including the discovery of contaminated drinking water in Washington, D.C. (2001-2004) and Flint, Michigan (2014-2016). Both crises were amplified by a lack of government transparency and disregard for existing public health regulations, ultimately resulting in a betrayal of public trust (Katner et al., 2016). Beyond acute exposure events, low-level environmental lead exposure is an often neglected but influential contributor to mortality rates in the U.S. (Lanphear et al., 2018). Given continued exposure, some researchers argue that existing health standards for lead must be updated to reflect the evolving science of lead (Bellinger et al., 2017).

Lead exposure is not a problem of the past and exists within a societal and institutional context that affects current and future management. Multiple facets of human-lead interactions make the topic an important subject of social science inquiry. First, despite remaining widespread in human environments, lead contamination is a low-visibility and low-salience hazard (Meyer et al., 2008). Lead can be visually challenging to detect (Binns et al., 2004; Triantafyllidou & Edwards, 2012). For some individuals, particularly among the general public, the issue of lead exposure may also not be readily recalled or conjure strong mental associations (Grupper et al., 2021; Higgins, 1996). One possible explanation for the low saliency of lead exposure risk is people believe previous public health efforts have eliminated the risk. Media amplification of specific exposure incidents, such as in Flint, Michigan, may suggest to people that lead exposure only occurs in certain places (i.e., lower-income cities with aging infrastructure) and even provoke feelings of indifference or denial toward potential exposure (Lyytimäki et al., 2011). Nevertheless, the risk of lead exposure is more widespread than many think which warrants a study of perceptions of lead at the national scale. Support for lead-related regulations and policies require support from all citizens, not only those who live in high-risk hotspots (e.g. Flint, Michigan). To date, no study has exclusively explored perceptions of lead exposure risk at the national scale. Exploring a broader range of perceptions can help identify gaps in understanding that may undermine efforts to secure public support, a necessary step in ensuring funding for existing programs to remove or contain environmental lead contamination.

Second, incidents like the Flint water crisis led to diminished trust in government management of lead. The government engages in primary prevention activities to remove lead hazards from the environment and reduce or prevent exposure (Center for Disease Control, 2021). When lead has not yet or cannot be fully remediated, the government must also engage in risk communication to inform the public and encourage individuals to protect themselves from exposure to lead. If the government is trusted on the issue of lead, several results may occur. The public may be more likely to follow risk guidance on health protective behaviors if they trust the government to provide accurate and reliable information about lead (Taylor-Clark et al., 2005). Alternatively, trust can have the opposite effect on individual-level behavior. Individuals may assume that the government is addressing the issue of lead exposure adequately, signaling to individuals that protective actions are less important or even unnecessary (Siegrist et al., 2021). If the government is trusted in its efforts to manage lead, associated risk management policies drafted may be more likely to receive public support. In the absence of government trust, policies to manage lead risks may be met with objection (Taylor-Clark et al., 2005).

There is a dearth of research on the general public's perceptions of lead risks and trust in government management of lead. Using results from a national online survey of U.S. citizens (n =

1,035), I provide an initial characterization of public perceptions of lead in the U.S. Chapter 1 aims are both descriptive and analytical. First, I seek to understand how citizens perceive the risk of lead exposure compared to other common environmental risks. I then examine the roles of trust in government management of lead and subjective knowledge about lead as predictors of perceived risk of lead exposure, including the potentially moderating role of subjective knowledge in the relationship between trust and perceived risk. In Chapter 2, I explore variations in trust in government management of lead. Using a typology of trust, I categorize respondents into four different types of trust – distrust, rejection, acceptance, and critical trust – based on levels of general trust and skepticism. Finally, I examine potential predictors of group membership. My results provide public health officials and policymakers with important insight into what the U.S. public thinks and knows about lead that can guide risk communication efforts, educational interventions, and future regulations.

Chapter 2: The Influence of Trust and Subjective Knowledge on the Perceived Risk of Lead Exposure

Abstract

Lead exposure can result in negative health outcomes due to its ability to persist and bioaccumulate in the body. Most existing research and risk communication efforts focus on at-risk population groups – pregnant women and children, low-income communities, and workers potentially exposed on the job. As such, little is known about perceptions of lead exposure risk among the public. Using cross-sectional data from a national survey of 1,035 U.S. residents, we 1) examined the relative risk of lead exposure and 2) measured the role of trust in government management of lead and subjective knowledge about lead as predictors of perceived risk of lead exposure, in addition to sociodemographic (age, gender, education, income, race, and political affiliation) and environmental (presence of children under three in household, pre-1978 residence) factors. We hypothesized that 1) respondents would perceive the lowest risk from lead exposure and 2) trust and perceived risk would be lower for individuals who self-estimate their knowledge to be high. Results reveal respondents perceive the lowest risk from lead exposure compared to other environmental risks. We also found that subjective knowledge does moderate the relationship between trust and perceived risk. When knowledge is low, trust and perceived risk are also low. This finding may suggest that a different approach to communication or a different messenger is needed. We also highlight the importance of household exposure, specifically lead-based paint, as a potential entry point for future risk communication efforts.

Introduction

Risk perception influences the hazards that the public is concerned about and how they respond, or fail to respond, to those hazards (Paek & Hove, 2017). Risks associated with industrial production and modernization tend to be highly complex, technical, and difficult for the general public to understand (Beck et al., 1992). In the absence of sufficient knowledge, citizens base their judgement of risk on other factors, such as trust. The public must trust that risk management entities will adequately assess, mitigate, and communicate relevant information about the risks. Some research suggests that trust and knowledge are intricately linked, such that trust is an important influence on risk perception when an individual has low knowledge about the risk (Siegrist & Cvetkovich, 2000). However, this relationship has not been sufficiently explored. In order to analyze this relationship, we test the influence of trust and subjective knowledge, and the potential interaction between the two, on perceived risk of lead exposure, a persistent environmental hazard in the United States (U.S.) and globally.

Research on the health effects of lead exposure is robust. Exposure to lead has declined in the U.S. during the past 50 years because of federal regulation and public health efforts to educate individuals on self-protective behaviors and increase awareness of associated negative health outcomes (Dignam et al., 2019). Despite this progress, lead exposure remains a persistent public health concern (Lanphear et al., 2018; O'Connor et al., 2018). Lead can affect all organs in the body, but the nervous system is most frequently affected in children and adults (Wani et al., 2015). Children and pregnant women are particularly vulnerable to detrimental health effects, especially those in low-income and minority groups (Meyer et al., 2008). In fact, the Centers for Disease Control (CDC) concluded in 2012 that there is no safe level of lead exposure in children (Vorvolakos et al., 2016). Moreover, exposure to lead in childhood can lead to increased incidence of negative health outcomes later in life (e.g. Reuben, 2018; Vig & Hu, 2000).

Despite our understanding of the physical hazard, little is known regarding public perceptions of lead exposure at the national level. One study showed that U.S. residents rated lead-related issues as less concerning relative to other environmental health risks such as drinking water quality (Shin et al., 2019). Research across disciplines more frequently focuses on specific subgroups at an increased risk of exposure to lead, such as women of child-bearing age, children, individuals working in certain hazardous occupations, and residents of mining communities (Cooper et al., 2020; Klemick et al., 2020; Vorvolakos et al., 2016). Although these population sectors are more likely to be impacted than others, all groups play a role in prevention efforts because individual behavior can help minimize lead exposure (Griffin & Dunwoody, 2000). For example, routine blood lead level testing in children can aid in early detection of possible sources of lead in the child's home (Boreland & Lyle, 2008).

We use data from a national survey of 1,035 U.S. residents to assess respondents' perceived risk of lead exposure, trust in government management of lead, and subjective knowledge about lead and associated health risks. Our objectives were to: (1) to measure the relative risk perception of lead exposure compared to other environmental risks, and (2) to assess the influence of trust in government management of lead and subjective knowledge about lead on perceived risk of lead exposure, while controlling for demographic and environmental variables. Understanding perceived risk of lead exposure, and the factors that underly those perceptions, can be applied to improve communication efforts between the government, experts, and the public, inform new public policies, and anticipate public responses to future events (e.g., discovery of lead-contaminated drinking water (Slovic et al., 1982).

Literature Review

Risk perception and lead exposure

The perception of risk has been studied in great detail to better understand the relationship between individuals and the threats they encounter (Wachinger et al., 2013). Risk perception can be defined as "people's beliefs, attitudes, judgements, and feelings, as well as the wider cultural and social dispositions they adopt towards things that [they] value" (Pidgeon, 1998, p.5). Several decades of research by Slovic and colleagues has identified that perceptions of risk tend to be shaped by numerous risk-specific attributes, including newness, uncontrollability, uncertainty, and catastrophic potential (Slovic, 1987). More recent social science research has expanded that understanding of risk perception formation to include the influence of individual characteristics, social and cultural context, and the physical and organizational dynamics of the hazard (Harclerode et al., 2016; Masuda & Garvin, 2006; Pidgeon, 1998).

Much of the existing research on perceptions of lead exposure has focused on specific geographic regions with contamination (Bostrom, 2008; Burger et al., 2012; Cooper et al., 2020; Friedman et al., 2015; Grasmück & Scholz, 2005; Harclerode et al., 2016; Weber et al., 2001). To our knowledge, few studies have examined perceptions of lead exposure at broader scales. Using data from a 2013 U.S. national *ConsumerStyles* survey, Shin et al. (2019) found that compared to other environmental health concerns, lead in paint and consumer products was least frequently listed among respondents' top three environmental issues. Similarly, when asked to rate the top three health concerns perceived to be affected by environmental issues, childhood lead poisoning was also least frequently included among respondents' top three issues. While lead poisoning is not considered a major contributor to global child mortality, it is estimated that approximately 3.6 million homes in the U.S. with at least one child have significant risk of exposure to lead from paint (Hauptman et al., 2017; Jacobs et al., 2002). Moreover, a population-based cohort study of 14,289 U.S. adults indicates that 18% of all-cause mortality can be attributed to elevated blood lead levels, the equivalent of approximately 412,000 deaths per year (Lanphear et al., 2018).

Why might risk perceptions related to lead exposure be different from other environmental risks? Lead is a low-visibility and low-salience hazard (Meyer et al., 2008). Evidence of the contaminant can be visually challenging to detect (Binns et al., 2004; Triantafyllidou & Edwards, 2012). The risk of lead exposure may also be perceptually challenging to consider if topics related to lead are not readily recalled or fail to conjure strong mental associations for an individual (Grupper et al., 2021; Higgins, 1996). This challenge may particularly affect members of the public who are less frequently exposed to messaging about lead-related issues compared to residents of highly contaminated areas (Rogers, 1997). Many chemical elements are difficult to contemplate because the associated risks "are caused by different kinds of substances, by sudden transient events and long-term processes, and they include various kinds and durations of effects in humans and other organisms, prompting different forms of recognition and recall" (Lyytimäki et al., 2011, p. 758). Lead may be a low-salience issue because people believe previous public health efforts have largely eliminated the risk. While federal regulations and policies to remove lead from paint, pipes, and gasoline have greatly lowered national blood lead levels, the risk of lead exposure has not been completed eradicated (Vorvolakos et al., 2016). Lead exposure could also be perceived as a highly localized problem where specific incidents occurred, such as the discovery of contaminated drinking water in Flint, Michigan (Jacobs, 2019). Media messages about lead exposure may be amplified during times of crisis, as was the case for the Flint water crisis. This heightened media attention during specific occasions may reinforce the notion that lead exposure is not a widespread concern and even provoke feelings of indifference or denial toward potential exposure (Lyytimäki et al., 2011). For these reasons, individuals may find it challenging to accurately consider the risk of lead exposure. Yet few studies have assessed lead risk perceptions in relation to other perceptions of other hazards at a national scale. Thus, we ask the following research question:

- **Research Question 1**: How does the perception of lead exposure risk compare to other environmental risks?

Given the low saliency and low visibility of lead, we hypothesize:

H1: Respondents will perceive the lowest relative risk from lead exposure

Trust in government management of lead

Trust shapes public perceptions of numerous risk-related issues (Besley & Shanahan, 2005; Bronfman et al., 2016; Grupper et al., 2021; Johnson & Scicchitano, 2000). When faced with uncertain hazards, people's judgements of risk may be influenced by the extent to which they trust the entities responsible for managing or regulating the hazard (Earle & Cvetkovich, 1995; Siegrist & Cvetkovich, 2000). By alleviating uncertainty, trust encourages citizens to rely on heuristics in their formation of subjective risk, reducing cognitive complexity and increasing information processing efficiency (Lee et al., 2005; Priest et al., 2003)

Past studies on the relationship between trust in a managing entity and risk perception show mixed results. Viklund (2003) examined the relationship between trust and perceived risk in and across four European countries. Results demonstrated that while trust does significantly predict perceived risk, the relationship varies by country, how trust is measured, and the type of risk. In a review of existing literature on trust and risk perception, Siegrist (2021) echoes these findings, concluding that the importance of trust varies by hazard and respondent group and that how trust is conceptualized and operationalized can have significant effects on the size of observed correlations. Other studies find that trust in risk management determines perceived risk when perceived knowledge about the risk is low (Siegrist & Cvetkovich, 2000). It is also possible that excessively high levels of trust in risk management authorities can result in people feeling little need to engage in personal preventive or protective behaviors (Bichard & Kazmierczak, 2012). This response may be problematic in the case of lead, because although there have been extensive efforts to remove sources of lead from the environment, potentially hazardous levels remain in many areas, so secondary prevention behaviors (e.g. blood lead screening tests) can offer an additional level of protection at the individual-level (Ettinger et al., 2019).

Building on the notion that the importance of trust appears to vary based on context, the present study seeks to explain the extent to which U.S. citizens trust the government's risk management efforts in the context of lead exposure. Trust may be particularly important in the context of lead because the local scale, distrust in government officials and scientists has been frequently cited by residents who oppose the federal cleanup of lead contamination in their local area (Messer et al., 2017). Furthermore, the individuals and institutions responsible for lead risk management are usually not personally known to the trustee (Siegrist, 2019). Because past findings about the relationship between trust and perceived risk are inconsistent, we do not formulate a hypothesis. We ask the following research question:

- **Research Question 2**: To what extent does trust predict the perceived risk of lead exposure?

Subjective knowledge of lead

Subjective knowledge refers to an individual's perception about their understanding of a topic whereas objective knowledge reflects the actual accurate information an individual possesses (Carlson et al., 2009). Subjective knowledge is often associated with subsequent attitudes, beliefs, and behaviors related to various environmental risks (Glanz et al., 1997; Liu & Jiao, 2018). Such associations are based on the notion that people who are knowledgeable about an issue, or perceive themselves to be knowledgeable, may be more likely engage with that issue (Frewer et al., 1994). Some research has demonstrated that levels of objective and subjective knowledge are often misaligned, such that an individual underestimates or overestimates their level of subjective knowledge relative to their objective knowledge (Stoutenborough & Vedlitz, 2014). In the present study, we focus strictly on subjective knowledge. While measurements of subjective knowledge can be unreliable if misestimated by an individual (Stoutenborough & Vedlitz, 2014), the accuracy of their assessment is less important than the extent to which the individual believes their knowledge to be sufficient (Frewer et al., 1994).

We explore subjective knowledge in relation to the perceived risk of lead exposure for two reasons. First, perceived risk may be influenced by public knowledge about the hazard, but this factor is somewhat under-researched (Buratti & Allwood, 2019; Frederiks et al., 2015). Grasmück & Scholz (2005) studied people living close to an area of heavy metal contaminated soil and found that participants who self-assessed their knowledge as higher perceived the risk of heavy metal exposure to be lower. In contrast, Zhu, Wei, and Zhao (2016) investigated residents living adjacent to a nuclear power plant under construction in China. Their results demonstrated that the higher the residents perceived their knowledge to be, the greater their perceived risks of nuclear power. To further complicate matters, in a review of literature on climate change risk perception, van der Linden (2017) found that subjective knowledge had no explanatory value in risk perception. It appears that the relationship between subjective knowledge and perceived risk is unclear and possibly domain-specific, particularly within the broader category of environmental risk.

The second reason that subjective knowledge is incorporated into this study is its potentially moderating role in the relationship between trust and perceived risk. Several researchers have hypothesized that the importance of trust varies as a function of knowledge (Earle & Cvetkovich, 1995; Luhmann, 2018; Siegrist & Cvetkovich, 2000). The public is generally assumed to possess less knowledge about risks compared to experts (Siegrist & Cvetkovich, 2000). In the absence of technical knowledge about lead, citizens may instead evaluate those who are responsible for managing lead rather than the actual risk of lead exposure itself. In contrast, when people feel sufficiently informed about lead, they can rely on their own knowledge in making judgements about risk. When knowledge is high, trust in experts or authorities managing the risk is less relevant. Siegrist & Cvetkovich (2000) empirically tested these expected variable relationships across 25 different hazards using correlation analysis and found support for the hypothesis that knowledge influences the relationship between trust and perceived risk. In the present study, we further this line of research by examining the role of subjective knowledge about lead as a moderator of the relationship between trust in government management of lead and the perceived risk of lead exposure. We ask the following research question:

- **Research Question 3**: To what extent does subjective knowledge predict the perceived risk of lead exposure?

Based on more consistent findings about the relationship between knowledge, trust, and risk perception (though with different hazards), we hypothesize the following:

> *H2*: High levels of subjective knowledge about lead will result in a diminished relationship between trust in government management and perceived risk.

In other words, for respondents who self-estimate their knowledge about lead to be high, trust in government management of lead will be a smaller predictor of perceived risk of lead exposure compared to low knowledge respondents.

Additional influences on perceived risk of lead exposure

Our study includes several control variables, including sociodemographic and environmental factors. While evidence predicting perceived risk by demographic factors is mixed, we anticipate that perceived risk of lead exposure will be higher among (1) older respondents who (2) identify as female, (3) are non-white, (4) report lower educational attainment, (5) report lower household income, and (6) identify as ideologically liberal. Previous studies have identified educational attainment and gender as factors influencing perceived risk such that women with lower levels of education tend to perceive a greater risk from environmental contamination (Flynn et al., 1994; Harclerode et al., 2016). Older and non-white individuals often perceive greater risk from environmental exposures (Johnson, 2002; Macias, 2016). Several studies have also demonstrated that females perceive greater risk from environmental hazards, including lead exposure, than males (Bickerstaff, 2004). Income has been found to significantly predict perceived risk of lead exposure such that lower income is associated with increased concern (Harclerode et al., 2016). Lastly, political conservatism is generally associated with lower levels of perceived risk of exposure to contamination (Mayer et al., 2017)

The remaining control variables include contextual factors that are expected to influence the perceived risk of lead exposure: presence of children under three years old in the household and living in a pre-1978 residence. Children under the age of three are at greatest risk for lead poisoning and especially susceptible to adverse health outcomes (Schnur & John, 2014). Older housing has also been identified as a key indicator of increased lead exposure (Jacobs et al., 2002). Although the use of lead in residential paint was banned in 1978, individuals living in a home built prior to 1978 may still be exposed to lead. We expect that respondents who live in a pre-1978 home and who have at least one child under the age of three will perceive greater risk from lead exposure.

Methods and Materials

Survey development

Study procedures were approved and certified exempt by the University of Idaho Institutional Review Board (#19-159). Three survey experts and environmental risk research and a group of eight non-experts pretested the initial survey. The feedback provided from this preliminary review informed several revisions to the survey to improve clarity and reduce measurement error prior to pilot testing (Wardropper et al., 2021). The survey was then pilot tested through Amazon's Mechanical Turk to assess the feasibility of the overall study procedures, including sampling, recruitment, data collection, and analysis (Edgar et al., 2016; Ruel et al., 2016). Based on results from the 100 respondents in the pilot test sample, no significant changes were made to the survey.

We distributed the final survey instrument online from December 2020 to January 2021. Respondents were recruited using a Qualtrics opt-in panel, a pool of respondents who voluntarily sign up to be solicited for survey participation. Eligible respondents were those at least 18 years of age and residing in the United States. We employed equal quotas for age, gender, and U.S. region (Northeast, Midwest, South, and West). While random sampling techniques are the preferred method for achieving representative samples (Yang & Banamah, 2014), sampling error can be reduced if the quota variables are tailored to the study (Terhanian et al., 2016). Age and gender have been shown to influence perceived risk across a number of different environmental and technological risks (Davidson & Freudenburg, 1996; Harclerode et al., 2016), which is why both variables were included in our quota criteria. For race and ethnicity, we intentionally oversampled non-white, minority groups for three reasons. First, survey researchers have struggled to adequately represent minority populations in survey research for decades (Herzing et al., 2019; McGraw et al., 1992; Ofstedal & Weir, 2011). Second, low-income and minority populations are disproportionately affected by lead exposure (Muller et al., 2018; Whitehead & Buchanan, 2019). Ensuring non-white populations were adequately represented in our sample allowed for comparisons between white and non-white respondents. Third, an aim of our broader research project is to examine differences in perceptions of lead across multiple racial and ethnic categories. Finally, we also created a quota for region to assess the variety of lead hazard perspectives across the U.S., and to increase responses from less populated regions. Respondents received a monetary incentive directly from independent panel providers, although the exact amount awarded was not disclosed to us by Qualtrics, per their panel company policies.

Measures

The three primary study variables were measured using a five-point unipolar scale and response labels were tailored to each item (see survey instrument in Appendix A). We used unipolar scales to avoid forcing respondents to consider between two, contrasting concepts (e.g. agree and disagree) (Alwin et al., 2018). We also chose to use a five-point scale because some studies suggest that it can result in higher response quality than seven- or eleven-point scales, can minimize respondent burden, and is most appropriate for use with unipolar response categories (Babakus & Mangold, 1992; Krosnick, 2018). Scales for demographic and environmental factors are described below. This analysis included the following survey items (full item wording for the three primary study variables can be found in Table 2.2):

Relative risk of lead exposure

We asked respondents to consider the risk of lead exposure compared to four other environmental risks using a response scale from 1 = "not at all risky" to 5 = "extremely risky". This question was included to offer a more descriptive understanding of lead exposure and was not used in the regression model. The items were adapted from a national survey that focused on the risk of mercury exposure (Turaga et al., 2014) and offer insight into how the risk of lead exposure compares to other commonly discussed environmental risks. The additional risks included air pollution, climate change, pollution of lakes and rivers, and ecological degradation. We replaced ecological degradation with habitat loss to increase specificity for respondents

Perceived risk of lead exposure

For our regression analysis, we measured perceived risk, the dependent variable, as a multidimensional concept with four main constructs including affect (6 items), perceived exposure (3 items), perceived severity (3 items), and perceived susceptibility (5 items). These items were adapted from two recent studies seeking to validate a multidimensional and broadly applicable measure of perceived risk (Walpole & Wilson, 2020; Wilson et al., 2019). The first construct, affect, asked respondents to consider several emotions they may experience when they consider being exposed to lead. The second construct, perceived exposure, asked respondents to consider the likelihood and frequency of being exposed to lead in the next year. Perceived severity requested respondents' consideration of the severity of impacts if exposure were to occur. The fourth and final construct, perceived susceptibility, focused on the respondents' perception of experiencing negative impacts if exposed to lead. All 17 individual items were averaged for each respondent to create a composite measure of perceived risk.

Trust in government management of lead

Trust was measured using 11 items adapted from Poortinga & Pidgeon (2003) that are believed to be related to trust, including competency, credibility, reliability, integrity (or vested interests), care, fairness, and openness. Respondents were asked to consider these trust-related concepts specifically as they pertain to the government's efforts to manage lead exposure risks in the U.S. As with perceived risk, the response categories were changed from bipolar to unipolar scales and a composite trust score was created for each respondent by averaging the 11 items.

Subjective knowledge

Respondents were asked to self-assess their lead-related knowledge. Eight items were used to determine a respondent's subjective knowledge. The first item considered the effects of lead on the human body and the second item asked respondents to compare their level of knowledge about the effects of lead on the human body compared to other. The remaining six items asked specifically about several issues related to lead: effects on the environment, effects on wildlife, sources of lead, how lead enters the human body, how to prevent lead exposure, and laws and regulations about lead. Respondents answered all items on a response scale from 1 = not at all knowledgeable to 5 = extremely knowledgeable. An "I don't know" option was not offered to respondents. The 8 items were averaged to create an individual subjective knowledge score.

Sociodemographic characteristics

Six sociodemographic items were included in the final analysis as controls due to their possible influence on perceived risk. Survey respondents reported their gender (0 = "male", 1 = "female", prefer not to answer (not included in analysis), age (continuous; calculated from year of birth), race and ethnicity (White alone, Black or African American, American Indian or Alaskan Native, Asian, Native Hawaiian or Pacific Islander, Hispanic or Latino, and Biracial or Multiracial), level of education (from no high school degree to advanced degree), income level (from less than $20,000 to greater than $120,000), and political ideology (from 1 = "strongly conservative" to 5 = "strongly liberal"; dummy coded 1 = "liberal", 0 = "not liberal). Race and ethnicity was recoded such that 1 = "non-White" and 0 = "White". Education and income were treated as continuous.

<u>Environmental factors</u>

We also included two items to measure environmental factors related to lead which we believed may influence perceptions of lead exposure risk. Respondents were asked to report if there were children in the home (0 = "no", 1 = "yes"). If "yes" was selected, they were prompted to report the age of their youngest child. We also asked respondents if their place of residence was built prior to 1978 (0 = no, 1 = yes). 122 respondents were unaware if their place of residents was built prior to 1978.

Statistical analysis

We used IBM SPSS Statistical Software (Version 25) to analyze the survey data. Descriptive statistics (means, frequencies, and standard deviations) for the independent variables were first calculated to characterize the sample. Prior to regression analysis, we examined measures of scale reliability for the primary study variables: perceived risk of lead exposure, trust in government management of lead, and subjective knowledge about lead. First, each scale was analyzed for internal reliability using Cronbach's alpha with a threshold of ≥.7 (Santos, 1999). The trust and subjective knowledge scales were both internally valid (Cronbach's alpha for subjective knowledge about lead = .948, trust in government management of lead = .818) (Table 2.2). We further investigated perceived risk to confirm whether the four-factor structure was an appropriate fit in this study. The Cronbach's alpha for the perceived risk of lead exposure, and each of the four individual constructs, exceeded the reliability threshold, except for perceived exposure (Cronbach's alpha for perceived risk of lead exposure = .914; affect = .928; perceived exposure = .575; perceived severity = .888; perceived susceptibility = .736). The second exposure item, "In the coming year, how confident are you that you will be exposed to lead where you live?", was removed from further analysis which increased internal reliability of perceived exposure to α = .772. Results from a confirmatory factor analysis to test the four-factor structure of our perceived risk variable also indicated removal of this item would improve model fit because it was negatively worded and thus had to be recoded for use in analysis. Reverse coded items have been shown to negatively affect scale reliability (Weems & Onwuegbuzie, 2001). This issue held true for one other item in the perceived susceptibility variable, "How protected would you feel if you were exposed to lead?" To improve scale reliability, we removed this item, which increased the construct reliability to α = .878. We also report the Spearman-Brown coefficient for the exposure construct (as opposed to Cronbach's alpha) because it is a more appropriate metric of reliability for two-item measures (Eisinga et al., 2013).

We then conducted hierarchical ordinary least squares (OLS) regression analysis with risk perception as the dependent variable. Hierarchical regression allows the researcher to enter independent variables in a series of steps, with each round of results demonstrating the relative relationship of the variables to the dependent variable while controlling for previously entered variables (Cohen et al., 2002). While multicollinearity is inevitable in moderated regression models, we used two diagnostic tests to identify potential issues (Chennamaneni et al., 2015). Bivariate correlations for all predictor variables were lower than 0.70, indicating that multicollinearity is likely not a major concern for subsequent model testing (Dormann et al., 2013). We also examined variance inflation factors (VIF) using a cutoff value of 10 given our larger sample size (Shieh, 2011). All VIF values were below 10 except for trust in government management of lead and subjective knowledge of lead. Interaction effects can introduce multicollinearity into the model but mean centering the main effects variables can reduce this issue (Aiken & West, 1991; Irwin & McClelland, 2001; Shieh, 2011). Once both the trust and subjective knowledge variables were mean centered, all VIF values fell below 10.

For our regression models (Table 2.4), we entered the six demographic variables in the first block (age, gender, race and ethnicity, income, educational attainment, and political ideology). The second block included environmental factors related to lead exposure (presence of children under the age of three in household, living in a residence built prior to 1978). In the third block, we added the trust in government management of lead and subjective knowledge of lead variables. In the fourth and final block, we incorporated the trust-knowledge interaction term.

Participants

Qualtrics estimated approximately 40,000 individuals were solicited for survey participation. A total of 3,939 individuals met the quota requirements, accepted the invitation to participate, and started the survey. 1,036 complete and valid survey responses were collected with our specific screening criteria. The sampling frame for opt-in panels is unknown so we were unable to calculate a response rate (Callegaro & DiSogra, 2008). However, our completion rate, or the proportion of screened and completed surveys to the total number of surveys started, was 26.3% (Eysenbach, 2004). One respondent was removed due to answering “prefer not to say” to the gender item, resulting in a final sample of 1,035.

Results

Sociodemographic characteristics

Survey respondents were 49.8% male and 37.7% white (not including those who identify as Hispanic), with an average age of 46.1 (SD = 16.9) years. 54.6% of respondents held a bachelor’s degree or higher. We compared demographic information from the sample with national census data (Table 2.1). Although the data tended to slightly overrepresent individuals with higher levels of education and underrepresent white individuals, the sample otherwise closely resembled national population demographics by age and gender.

Table 2.1. Demographic characteristics of survey sample (n = 1,035)

Characteristic	Sample Mean (SD) (% (frequency))	U.S.[1] (%)
Age (median)	46.1 (16.9)	38.5
18-24	12.9% (133)	9.1%
25-44	38.3% (396)	26.7%
45-64	31.1% (322)	25.3%
65+	17.8% (184)	16.5%
Gender		
Female	50.2% (520)	50.8%
Male	49.8% (515)	49.2%
Race/ethnicity		
White	37.7% (391)	60.1%
Black or African American	17.7% (183)	13.4%
American Indian or Alaskan Native	16.1% (167)	1.3%
Hispanic or Latino	13.9% (144)	18.5%
Asian	6.4% (66)	5.9%
Native Hawaiian or Pacific Islander	4.5% (47)	0.2%
Biracial or multiracial	3.7% (38)	2.8%
Highest education		
Advanced degree	17.9% (185)	9.7%
College degree (2 or 4 year)	36.7% (380)	24.8%
Some college but no degree	24.3% (252)	13.4%
High school graduate	18.9% (196)	21.4%
Less than high school degree	2.1% (22)	7.3%
Occupational status		
Working full-time	50.2% (520)	
Working part-time	11.3% (117)	
Student	5.5% (57)	
Unemployed	5.5% (57)	-
Retired	18.5% (191)	
Homemaker	5.8% (60)	
Other	3.2% (33)	
Approximate household income (median)		$68,703
Less than $20,000	12.1% (125)	
$20,000-$49,999	25.0% (259)	
$50,000-$79,999	30.6% (317)	
$80,000-$99,999	12.7% (131)	-
$100,000 - $119,999	7.1% (74)	
$120,000 or more	12.5% (129)	
Region[1]		
Northeast	20.9% (216)	17.1%
Midwest	24.0% (248)	20.8%
South	28.8% (298)	28.3%
West	26.4% (273)	23.9%

[1] 2019 American Community Survey.

[2] Northeast includes: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, and Pennsylvania. Midwest includes: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. South includes: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. West includes: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Table 2.2. Means, standard deviations, and Cronbach's alphas for the primary study variables: perceived risk of lead exposure, trust in government management of lead, and subjective knowledge about lead

Scale	Mean (SD)	α
Perceived risk of lead exposure (15 items)	2.95 (.86)	.917
Affect	3.11 (.33)	.928
How concerned are you (if at all) about the potential negative effects of exposure to lead?		
When you think about being exposed to lead, to what extent do you feel fearful?		
When you think about being exposed to lead, to what extent do you feel anxious?		
When you think about being exposed to lead, to what extent do you feel worried?		
Considering any potential effects that being exposed to lead might have on you personally, how concerned are you about exposure to lead?		
Considering any potential effects that being exposed to lead might have on others, how concerned are you about exposure to lead?		
Exposure[2]	2.67 (.58)	.772
In the coming year, how likely is it that you will be exposed to lead where you live?		
How often are you exposed to lead where you live?		
Perceived severity	2.97 (.10)	.888
If you were exposed to lead, how severe of an impact would it have on you personally?		
How severe are the impacts of lead exposure to you?		
If you were exposed to lead, how devastating would the impacts be?		
Perceived susceptibility	2.94 (.24)	.878
If you were exposed to lead today, how likely is it that you would experience negative impacts?		
How likely is it that you would be negatively impacted if exposed to lead?		
How likely is it that your family would be negatively impacted if exposed to lead?		
How likely is it that your property would be negatively impacted if exposed to lead?		
Trust in government management of lead[1] (11 items)	3.09 (.68)	.818
Competency	3.12 (.95)	.850
How would you rate the government?		
How competent is the government?		
How skilled are the people who work for the government?		
Credibility	3.40 (1.21)	-
How likely is the government to distort facts?		
Reliability	3.20 (1.24)	-
How likely is the government to change policies without good reason?		
Integrity	3.67 (1.02)	-
How much is the government influenced by industry?		
Care	2.93 (1.04)	.875
How likely is the government to act in the public interest?		
How likely is the government to listen to concerns raised by the public?		
How likely is the government to listen to what ordinary people think?		
Fairness	2.82 (1.15)	-
How fair is the government's decision-making process?		
Openness		
How willing is the government to provide all relevant information to the public?	2.77 (1.22)	-
Subjective knowledge about lead (8 items)	2.69 (1.06)	.948
How would you rate your own knowledge about the impact of lead on the human body?		
Compared to other people, how would you rate your own knowledge about the impact of lead on the human body?		
How knowledgeable do you think you are about the following issues related to lead:		
Effects on the environment		
Effects on wildlife		
Sources of lead		
How lead enters the human body		
How to prevent lead exposure		
Laws and regulations about lead		

[1]All items included stem, "With respect to managing lead risks". [2]Spearman-Brown coefficient reported because it is a more appropriate measure of reliability for a two-item factor.

Relative risk of lead exposure

To obtain a descriptive understanding of how the risk of lead exposure compares to other environmental risks (Objective 1), the respondents rated the following risks: air pollution, climate change, pollution of lakes and rivers, exposure to lead, and habitat loss. Compared to the other four environmental risks, respondents more frequently considered lead exposure “not at all risky” or “slightly risky” (Table 2.3). Exposure to lead also had the lowest average score (M = 3.48). Two-tailed paired sample t-tests show that exposure to lead is perceived to pose lower risk than any of the other risks: air pollution (diff. in means = -0.40, t = -12.7, df = 1034 , p < .001), climate change (diff. in means = -0.34, t = -9.3, df = 1034, p < .001), pollution of rivers and lakes (diff. in means = -0.60, t = -18.7, df = 1034, p < .001), and habitat loss (diff. in means = -0.36, t = -10.9, df = 1034, p < .001).

Table 2.3. Reported risk perceptions (average score and percent of respondents) for common environmental risks: "In your opinion, how risky are the following environmental issues?” and difference in means relative to perceived risk of exposure to lead

Environmental risk	Mean	Not at all risky – slightly risky	Somewhat risky	Moderately risky – extremely risky	Difference in means (2-sample t-test with unequal variances)
Pollution of rivers and lakes	4.08	9.4%	17.6%	53.0%	-0.60*** (t = -18.7, df = 1034)
Air pollution	3.88	14.3%	19.2%	66.5%	-0.40***(t = -12.7, df = 1034)
Habitat loss	3.84	14.6%	22.1%	63.3%	-0.36*** (t = -10.9, df = 1034)
Climate change	3.82	18.5%	16.6%	64.9%	-0.34*** (t = -9.3, df = 1034)
Exposure to lead	3.48	22.2%	26.1%	51.8%	-

*** p <.001

Regression analyses

Table 2.4 reports the results of the four-stage hierarchical multiple regression analysis. Model 1 (R^2 = .090) includes only control variables for sociodemographics and political ideology. Older respondents perceived a lower from lead exposure (β = -.212, p < .001). Higher levels of education (β = .117, p < .001), higher income (β = .123, p < .001), and identifying as more politically liberal positively predicted perceived risk of lead exposure (β = .078, p < .01). Model 2 adds variables for environmental factors that may affect levels of perceived risk. Each of the statistically significant control variables from Model 1 retained its significance (age: β = -.132, p < .001; education: β = .032, p < .001; income: β = -.212, p < .001; ideology: β = -.077, p < .01). Of the two environmental factors added in the second block, only living in a residence built prior to 1978 significantly predicted perceived risk of lead exposure (β = .049, p < .01). Individuals living in pre-1978 dwellings perceived a greater risk. Model 2 produced a marginally improved but statistically significant R^2 value over Model 1 (R^2 = .093).

Model 3 incorporates the two primary study variables, trust in government management of lead and subjective knowledge about lead. Both variables positively and significantly predicted perceived risk of lead exposure (trust: β = .236, p < .001; knowledge: β = .305, p < .001). Several variables from the two previous models were no longer significant. In addition to the primary study variables, only age and living in a pre-1978 residence significantly predicted perceived risk of lead exposure in Model 3. Older respondents perceived less risk from lead exposure than younger respondents (β = -.129, p < .001). Individuals aware that their residence was built prior to 1978 perceived a greater risk from lead exposure than those who answered "no" or "I don't know" (β = -.070, p < .05). The R^2 value for Model 3 is more than double that of Model 2 and significant, suggesting slightly better model fit with a moderate effect size (R^2 = .255) (Ferguson, 2009).

The fourth model introduced the interaction term between trust in government management of lead and subjective knowledge of lead to examine the potentially moderating effect of subjective knowledge on perceived risk of lead exposure. There was a significant difference between Models 3 and 4 although the increase in the R^2 was marginal (R^2 = .264). The effects of age and living in a pre-1978 residence remained the same as in the previous models (age: β = -.117, p < .001; β = -.068, p < .01). Female respondents reported significantly higher levels of perceived risk of lead exposure than males in Model 4 (β = .060, p < .05). Both main effect variables, trust in government management of lead and subjective knowledge about lead, retained their significance (trust: β = .204, p < .001; knowledge: β = .290, p < .001). The interaction effect was also significant (β = .108, p < .001). The effect of race and having children under the age of three were not statistically significant in any of the models.

To aid in interpretation of the interaction effect, a plot was created demonstrating the influence of trust in government management of lead on the perceived risk of lead exposure as moderated by subjective knowledge of lead (Figure 2.1). For graphing purposes, we used the non-centered trust and subjective knowledge variables. Subjective knowledge was also dichotomized into a high and low knowledge group (using the median value of 2.63 as a cutoff).

Table 2.4. Summary of hierarchical ordinary least squares regression for variables predicting perceived risk of lead exposure (n = 1,035)

Model	Model 1		Model 2		Model 3		Model 4	
Predictor variable	*B* (SE)	*β*	*B* (SE)	*β*	*B* (SE)	*β*	*B* (SE)	*β*
Age	-.012 (.002)***	-.212	-.013 (.002)***	-.132	-.007 (.002)***	-.129	-.007 (.002)***	-.117
Gender (female)	.074 (.061)	-.039	-.076 (.060)	-.043	.110 (.056)	.058	.115 (.056)*	.060
Race/ ethnicity (non-white)	-.062 (.063)	-.032	-.064 (.063)	.006	.012 (.056)	.006	.037 (.058)	.019
Education	.105 (.031)***	.117	.187 (.063)***	.032	.031 (.020)	.035	.027 (.028)	.030
Income	.078 (.062)***	.123	.083 (.022)***	.042	.034 (.020)	.054	.029 (.020)	.046
Political ideology (liberal)	.162 (.062)**	.078	.161 (.062)**	-.077	.090 (.058)	.043	.084 (.056)	.040
Presence of child ≤ 3	-	-	.113 (.099)	.032	.051 (.090)	.015	.052 (.090)	.016
House built pre-1978	-	-	.189 (.060)**	.049	.138 (.055)*	.070	.135 (.054)**	.068
Trust in government	-	-	-	-	.328 (.041)***	.236	.284 (.043)***	.204
Subjective knowledge	-	-	-	-	.273 (.027)***	.305	.259 (.027)***	.290
Trust x subjective knowledge	-	-	-	-	-	-	.119 (.003)***	.108
Adjusted R^2		.090		.093		.255		.264
F for ΔR^2		16.94***		5.65**		112.97***		12.89***

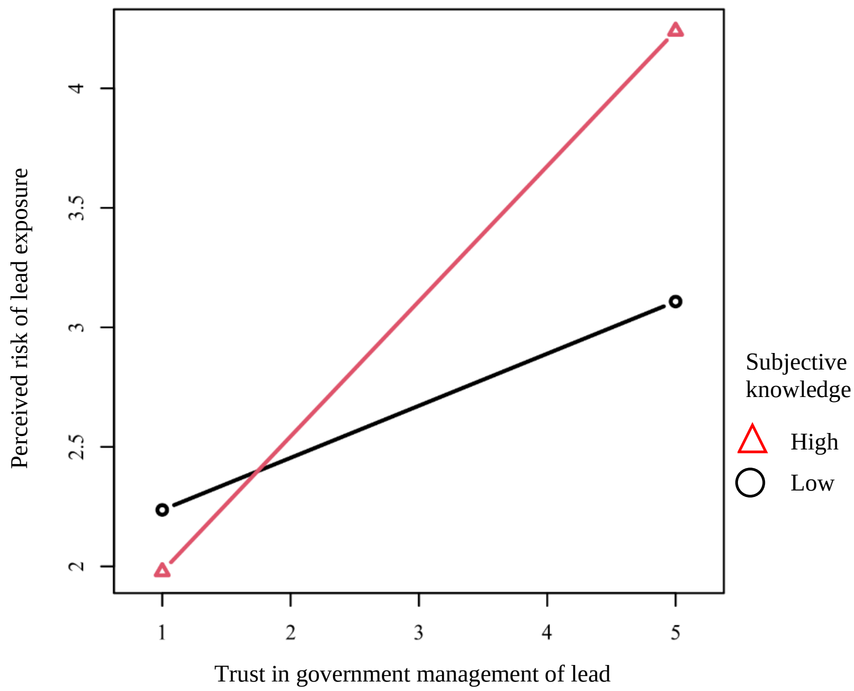

Figure 2.1. The influence of trust in government management of lead on the perceived risk of lead exposure, as moderated by subjective knowledge about lead

Discussion

Lead exposure does not appear to be an issue of high national concern. Despite our study's focus on lead, respondents perceived the risk of lead exposure to be lower than the risks posed by other common environmental issues. This lower relative risk perception of lead exposure may be partially explained by "risk attenuation" (Harclerode et al., 2016; Kasperson et al., 1988; Shin et al., 2019). Risk attenuation describes the phenomenon in which "abstract and seemingly remote risks are outweighed by more immediate and perceptible ones" (Harclerode et al., 2016, p. 6). On average, respondents perceived the highest risk for air pollution and pollution of rivers and lakes, and the lowest risk for lead exposure. This may suggest that respondents perceive the risk of lead exposure as delayed and imperceptible. While exposure to lead can result in acute health effects, research also demonstrates that associated impacts can take years to manifest (e.g. Kim et al., 1995). Shin et al. (2019) report similar results wherein respondents most frequently labelled outdoor air quality and drinking water quality as a major environmental concern related to potential health impacts but lead exposure through paint or consumer products was least frequently reported as an environmental health concern. In a study of mercury risk perception, Turaga et al. (2014) found that U.S. citizens perceived less risk from mercury exposure compared to pollution of rivers and lakes.

The importance of understanding perceived risk of lead exposure may be most acute in specific high-risk communities, but because many lead hazard policies exist at the national level, it is important to understand how the general population perceives the risk of lead exposure. Successful implementation of policies to control lead require widespread participation and support, extending beyond those most at-risk from lead exposure (Turaga et al., 2014). The overall moderate levels of perceived risk documented here may create friction for the enactment of future lead-related policies. However, it has been suggested that high levels of perceived risk alone do not lead to action to alleviate risk (Smith & Mayer, 2018). Targeted risk communication campaigns may still be beneficial in increasing awareness among the general public about the prevalence of lead exposure in the US, particularly in high-risk areas and among at-risk subgroups.

Our primary independent variables in the regression models—trust in government management of lead and subjective knowledge about lead—both significantly predicted perceived risk of lead exposure, although the regression coefficients were modest in size. Regardless of subjective knowledge level, individuals with higher levels of trust in the government management of lead demonstrated higher levels of perceived risk of lead exposure. This result is consistent with some previous research (Grupper et al., 2021; Siegrist et al., 2000), although other scholars argue that the importance of trust in predicting perceived risk may be overstated (Viklund, 2003).

Subjective knowledge about lead positively predicted perceived risk of lead exposure. Our results contradict those of Grasmück & Scholz (2005), who found that high subjective knowledge was associated with a lower perceived risk of exposure to heavy metals from contaminated soil. In a study of residents living on contaminated soil, (Vandermoere, 2008) found that subjective knowledge significantly and negatively predicted hazard perception (the seriousness of contamination), but did not significantly predict risk perception (the seriousness of health effects if exposed to contaminated soil). The author explains the divergence of these results from the assumptions of the knowledge deficit model (KDM), which assumes that the gap between expert and lay perceptions of risk can be reduced if the public's knowledge about the risk increases (Scheufele, 2013; Wynne, 1982). The KDM has been widely criticized for its oversimplification of the connection between information and public perceptions (Suldovsky, 2017), but the importance of knowledge in influencing perceptions of risk cannot be completely ignored. Attempts to understand public perceptions should instead contextualize the influence of knowledge possession among social, cultural, and personal factors (Lewenstein, 2003). The main effect of subjective knowledge on perceived risk of lead exposure found here may support the inclusion and importance of knowledge in efforts to understand public perceptions, at least in the context of lead risk management.

The positive effect of trust in government management of lead on perceived risk of lead exposure was stronger for individuals who reported high levels of subjective knowledge compared to those with low subjective knowledge. It was originally hypothesized that subjective knowledge would moderate the relationship between trust and risk perception such that respondents who self-estimate their knowledge to be low, trust would better predict perceptions of risk. Instead, our results show the opposite. Respondents who believe they know a lot about lead reported higher levels of trust in government management of lead and high levels of perceived risk of lead exposure. One possible explanation for this finding is that individuals do not possess enough knowledge (or perceive their knowledge to be inadequate) to form strong opinions as to the risk of lead exposure or the government's efforts to manage lead. Some respondents may feel uninformed and choose to disengage with the issue entirely.

The only sociodemographic factor to significantly predict perceived risk of lead exposure across all four models was age. Previous research has demonstrated that older individuals frequently report lower environmental concern (Casey & Scott, 2006; Haltinner & Sarathchandra, 2021). Identifying as more politically liberal also significantly predicted perceived risk, but the effect disappeared in Models 3 and 4. Such was the case for both education and income. Lead exposure may be politically polarizing, but not to the extent of other environmental risks, such as climate change, for which political ideology strongly predicted perceived risk in past studies (Buttel & Flinn, 1978; Cruz, 2017; Mayer et al., 2017). Previous research asserts conservative leaning individuals tend to be less sensitive to "diffuse threats", or those threats that collectively affect individuals and others (Choma et al., 2013). Our results pertaining to political ideology may lend support to this connection between political conservatism and perceived risk concerning hazards with wide-reaching impacts. For conservative leaning individuals, lead exposure may be perceived only as an issue in specific places and for specific people, and not an issue of national interest. Across all four models, we found no significant statistical association between race and ethnicity and perceived risk. We found this result surprising given that it is well-documented that racial and ethnic minorities in the U.S. are disproportionately exposed to environmental contaminants (Ash & Boyce, 2018; Mennis, 2002; Whitehead & Buchanan, 2019). Additionally, we over-sampled non-white individuals in an attempt to capture racial and ethnic differences in perceived risk which previous research has found to be strong independent predictors of environmental risk perception (Macias, 2016).

We also explored the potential influence of two environmental factors related to lead on perceived risk of lead exposure: presence of children under three in the household and residence in a pre-1978 building. Respondents in households with children under three did not perceive statistically significant greater risk from lead exposure, even though young children are especially susceptible to acute and chronic health effects (Bellinger et al., 2017). This result is consistent with research conducted by Harclerode et al. (2016). In contrast, individuals living in residences built prior to 1978 consistently perceived higher risk of lead exposure. Respondents appear to be aware of the potential presence of lead paint in older homes. This finding could suggest that household exposure, particularly to lead-based paint, might be a useful entry point for future efforts to increase awareness and perceived risk of lead exposure.

Our study has several limitations. Despite efforts to maximize sample representativeness with the use of demographic quotas, the findings here should not be generalized to the national population. Furthermore, our four regression models did not demonstrate exceptional fit. However, this does not necessarily indicate that the models are not psychologically plausible in the context of lead exposure (Siegrist, 2021). Other variables not included in this study could explain greater variance in perceived risk. For example, comparative optimism (the belief that oneself is less prone to adverse health effects of lead exposure compared to others) may help explain why respondents in our sample reported relatively low levels of concern for lead exposure (Wolde et al., 2019). Furthermore, a more comprehensive measure to contextualize respondent's objective level of risk, beyond the two variables (children under three, pre-1978 housing) included in the present study, could further elucidate variations in perceived risk.

We also recognize that focusing on the combined efforts of the government may have been too broad for accurate application in this context. Given the low saliency of lead exposure, we assumed respondents might be unaware of how different institutions and agencies are involved in the management of lead exposure risk or have trouble distinguishing between multiple entities. Our trust variable weakly, albeit significantly, predicted the perceived risk of lead exposure. Such results are not uncommon as previous research has demonstrated that the conceptualization and operationalization of trust can greatly influence the size of observed relationships (Siegrist, 2019). It is possible that our measurement of trust is not the most appropriate for the context of lead exposure and that other structures may better predict the perceived risk of lead exposure. For example, Stern & Coleman (2015) offer an alternative typology of trust which includes dispositional trust. Dispositional trust can refer to a general predisposition to trust others, regardless of context. Alternatively, it can describe an individual's tendency to trust a person or institution because of perceived judgements of authority and legitimacy. This type of trust may be particularly important in large-scale management contexts because individuals may struggle to evaluate the number of individuals and institutions involved (Sønderskov, 2011). Despite the numerous types, it appears that trust is an important consideration when examining perceived risk in this context but warrants further attention.

Lastly, we aknowledge the potential influence of the COVID-19 pandemic on our respondents' level of engagement and ability to critically consider the risk of lead exposure. Previous research has demonstrated that perceived risk of environmental issues may vary in response to other pressing societal issues, often referred to as the "finite pool of worry" (Bostrom et al., 2020; Evensen et al., 2021). Individuals possess limited emotional resources such that as concern increases for one issue (e.g. COVID-19), concern for other issues decreases. As such, our results could vary if this survey were to be conducted at another point time during which a global pandemic was not occurring. However, we should not completely rule out the possibility that lead exposure simply does not raise concern among the general U.S. public.

Conclusion

This study increases understanding of how the U.S. public perceives the risk of lead exposure. Future research should explore objective measures of knowledge as research shows subjective and objective knowledge are frequently misaligned (Carlson et al., 2009). Understanding what people accurately know about lead, and how this compares to perceptions of knowledge, can provide important insight for the tailoring of subsequent risk communication strategies and educational interventions. While some studies have assessed knowledge pertaining to lead, they have primarily focused on specific population subgroups (e.g. Wolde et al., 2019). As noted by Earle (2010), trust is critical to implementing effective risk communication and mitigation strategies. Future studies should also consider exploring different types of trust as predictors of perceived risk of lead exposure, given the documented importance of how trust is conceptualized and operationalized. For example, the influence of subjective knowledge may differ if respondents are asked to consider trust in specific government agencies involved in the risk management of lead such as the EPA or CDC (e.g. Hamm et al., 2019). Lastly, future research should employ comparative methods to elaborate our understanding of the saliency of lead exposure. Exploring perceptions of lead among the national population relative to a region or series of communities characterized by higher risk of lead exposure could provide insight into differences, if any, that may exist as a function of exposure risk.

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Chapter 3: Trust in Government Management of Lead in the U.S.

Abstract

Lead exposure remains a pertinent public health issue in the United States (U.S.) despite multiple regulations that control sources of lead in the environment. Localized incidents of lead exposure and conflicting messages from the government underscore the importance of trust in effective management of lead risks. Trust is a crucial factor in the perception of risk, effective risk communication, and attitudes towards risk management policies. We examine trust in government management of lead using results from a national online survey of U.S. citizens (n = 1,035). Using a conceptualization of trust in government management of lead as a function of general trust (i.e., evaluation of positive aspects) and skepticism (i.e., a doubtful view of government). We categorize respondents into one of four types of trust in government management of lead – rejection, distrust, critical trust, and acceptance – based on levels of general trust and skepticism. We then examine characteristics of each group using sociodemographic, environmental, and other variables such as trust in scientists and subjective knowledge. Findings indicate that more than half (58.9%) of respondents demonstrate high levels of skepticism in government management of lead. Respondents are almost evenly split between high and low levels of general trust (48.1% low). This framework could be a valuable tool for targeting risk communication and educational efforts to specific segments of the population.

Introduction

While federal regulations to mitigate environmental lead hazards and reduce exposures in the United States (U.S.) have helped to reduce national blood lead levels, lead exposure remains a persistent public health issue. Localized incidences of lead exposure continue to arise across the country, such as the discovery of contaminated drinking water in Flint, Michigan in 2014. Several governmental agencies failed to respond to the elevated levels of lead in Flint drinking water despite public outcry from local citizens (Butler et al., 2016). The Flint water crisis raised questions as to the pervasiveness of modern-day lead exposure and the trustworthiness of the government to mitigate the risk. Subsequently, then-Environmental Protection Agency (EPA) administrator, Scott Pruitt, declared a “war on lead”. Pruitt sought to develop a federal strategy to reduce childhood lead exposure, particularly via drinking water, and update the nation’s water infrastructure (Siegel, 2018). Simultaneous to the war on lead, the EPA sought to pass a “science transparency rule”, which would have dismissed or de-emphasized studies based on data that are not publicly available, including many public health datasets (Friedman, 2018). To many scientists and public health officials, these two endeavors appeared to be in direct contradiction, as targeting lead exposure would be undermined by the science transparency rule.

The mixed messages offered by the EPA speak to a broader issue within the policymaking realm: trust in government (Taylor-Clark et al., 2005), trust in science (Gauchat, 2012; Haerlin & Parr, 1999), and the relationship between science and policy in the context of environmental management (Dale et al., 2019; Hickey et al., 2013) Trust is a crucial factor in the perception of risk, effective risk communication, and attitudes towards risk management policies (Kasperson, 1992; Renn & Levine, 1991; Visschers & Siegrist, 2008). In the present study, we specifically focus on the government as the object of trust. We distinguish between two main types of government efforts to manage lead hazards in the U.S. First, the government engages in primary prevention activities which seek to directly remove lead hazards from the environment in order to reduce or prevent exposure (Center for Disease Control, 2021). Public support is necessary to fund existing programs to remove or contain environmental lead contamination. When lead has not yet or cannot be fully remediated, the government must also engage in risk communication to inform the public and encourage individuals to protect themselves from exposure to lead. If the government is trusted on the issue of lead, several results may occur. The public may be more likely to follow risk guidance on health protective behaviors if they trust the government to provide accurate and reliable information about lead (Taylor-Clark et al., 2005). Alternatively, trust can have the opposite effect on individual-level behavior. Individuals may believe that the government is addressing the issue of lead exposure adequately, signaling to individuals that protective actions are less important or even unnecessary

(Siegrist et al., 2021). Finally, if the government is trusted in its efforts to manage lead, associated risk management policies drafted may be more likely to receive public support. In the absence of government trust, policies to manage lead risks may be met with objection (Taylor-Clark et al., 2005).

Much of the existing risk research on trust has focused on what constitutes and contributes to trust or how trust predicts perceived risk and public acceptance (Earle, 2010). In the present study, we extend this line of research by testing a previously validated two-factor structure of trust including general trust (or reliance) and skepticism with data from a national online survey of U.S. citizens (n = 1,035). Based on levels of both general trust and skepticism, we classify survey respondents into one of four types of trust: distrust, acceptance, critical trust, and rejection. By categorizing respondents, we can examine predictors of group membership. Examining trust along such a continuum can allow the implementation of appropriate strategies such as tailoring of risk messages and targeted policy making. In this way, we offer a unique approach to the study of trust in the context of risk, by focusing not only on characteristics of the entity to be trusted, but characteristics of the individual who trusts.

Literature Review

Trust in government

We draw from risk, political science, and public administration literature to bridge two types of trust – trust in government and trust in risk management – to conceptualize trust in the government management of lead. In the context of risk, one of the primary functions of trust is to simplify decision-making for laypeople in the absence of risk-specific knowledge (Siegrist, 2019). Although trusting in another serves to reduce complexity in the present, it simultaneously creates uncertainty because the future behavior and intentions of the other are delayed and cannot be guaranteed (Luhmann, 2018). In other cases, relying too heavily on trust can lead people to believe they are no longer vulnerable to the risk and fail to engage in personal protective measures unnecessary (Paek & Hove, 2017).

Our understanding of trust is complicated, at least in part, by divergent explanations as to what constitutes and contributes to trust. Scholars frequently use different terms to describe similar concepts. A commonly cited definition among risk scholars offered by Rousseau et al. (1998) states that “trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another” (p. 395). Trust in the government specifically can be defined as “how positively citizens perceive government’s performance relative to their expectations” (Hetherington, 2005, p. 9)

Many researchers believe trust to be multifaceted and multidimensional. Two primary dimensions are: characteristics of the object of trust (i.e., the organization managing or communicating the risk), and social relations between the individual and the object of trust. With respect to the object of trust, competence, fairness, openness, objectivity, integrity, and honesty are among the most commonly cited dimensions (Nakayachi & Cvetkovich, 2010; Renn & Levine, 1991). Social relations refers to judgements of similar values between the individual and object of trust (i.e. another individual, an institution) that provide evidence of good intentions (Earle, 2010). Confidence, as defined by Siegrist (2019), is the belief that future events will occur as expected based on past experiences. Similarly, judgements of ability are based on previous evidence or past experience which indicate to an individual that future actions will be consistent and reliable. Research suggests that the social relations aspect of trust is more important than ability or characteristics of the trust object (Earle, 2010). In the context of lead management, believing the government's intentions are either good or bad may outweigh the government's ability to manage lead hazards (Earle et al., 2007).

Several models of trust have been established that follow a two-dimensional conceptualization of trust. For example, the Trust, Confidence, and Cooperation (TCC) model focuses on the difference between trust and confidence and how these concepts can lead to cooperative risk management (Earle et al., 2007). In their study of trust in information sources about food risks, Frewer et al. (1996) found general trustworthiness and vested interests to best model trust. Metlay (1999) proposed a similar trust structure, composed of general trustworthiness and competency, in a study of trust in the U.S. Department of Energy. To weave together existing theories, Poortinga & Pidgeon (2003) tested both dimensional structures from Metlay (1999) and Frewer et al. (1996) across five hazard contexts, drawing also on work from Peters et al. (1997), Renn & Levine (1991), Johnson (1999), and others. Two dimensions emerged from their research: general trust and skepticism.

In their study of the dimensionality of trust in government risk regulation, Poortinga and Pidgeon (2003) tested the applicability of the two-factor (general trust and skepticism) structure across five different hazards including climate change, mobile phones, radioactive waste, genetically modified food, and genetic testing. Despite acquiring a distinct sample for each of the five hazards, the authors were surprised to find that the two-factor solution remained consistent. The authors draw on an interesting perspective offered by Pidgeon et al. (2003) to contextualize their results. Pidgeon et al. (2003) suggests that trust is best conceptualized as existing along a spectrum based on levels of general trust (or reliance) and skepticism, where trust can be typified into four main categories

(Figure 3.1). This conceptualization views trust as a more nuanced concept and acknowledges the dynamic nature of trust, rather than merely claiming the presence or absence of trust.

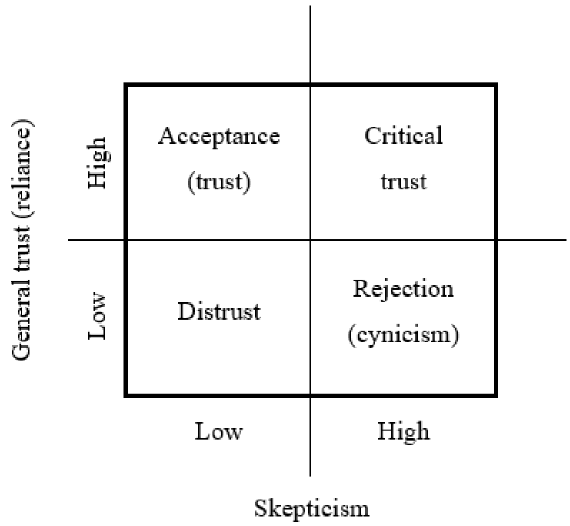

Figure 3.1. Typology of trust in government adapted from Pidgeon et al. (2003)

Based on this framework, we can describe how trust in government management of lead may vary as a function of general trust and skepticism. Low levels of general trust can be matched with low or high levels of skepticism, resulting in distrust or rejection of government management of lead, respectively. An individual in the distrust group is likely to be uncritical of government efforts to manage lead, yet simultaneously unwilling to rely on those efforts. Such an individual may be more inclined to disengage from the issue of lead exposure entirely. Rejection (or cynicism) describes individuals who will not rely on the government's efforts to manage lead and are doubtful of the effectiveness of such efforts. Information from the government pertaining to lead is likely to be rejected by an individual in the rejection group. In contrast, high levels of general trust paired with low skepticism results in acceptance. Individuals are likely to uncritically accept and believe that the efforts of the government to manage lead hazards are adequate. High levels of both general trust and skepticism result in critical trust. Critical trust is described by Poortinga and Pidgeon (2003) as a "healthy type of trust" (p. 971). Individuals in the critical trust group are willing to rely on the government to manage lead risks but unwilling to accept these efforts without question. Achieving acceptance (high general trust, low skepticism) may result in less friction during the implementation process of lead-related policies (Parkins et al., 2017). However, some skepticism is necessary for effective public oversight and political accountability, as evidenced by the water crisis in Flint, Michigan (Parkins et al., 2017; Poortinga & Pidgeon, 2003).

Based on this brief review of the literature on trust, our primary two study objectives and associated hypotheses are as follows:

- **Objective 1**: Test the two-factor structure of trust proposed by Poortinga and Pidgeon (2003), including general trust and skepticism, for trust in government management of lead
  H1: Given the demonstrated consistency of the two-factor structure across five different hazards in Poortinga and Pidgeon (2003), we expect the same structure to be present in the context of lead.
- **Objective 2**: Classify respondents into groups based on levels of general trust and skepticism
  H2: Given heightened media attention surrounding specific incidences of lead contamination in the previous decade, a larger proportion of respondents will question the government's reliability, integrity, and credibility and have higher levels of skepticism.

Environmental factors

Contextual factors related to lead may influence the degree to which an individual trusts the government to manage lead risks. We include the presence of children under three years old in the household and living in a pre-1978 residence. Children under the age of three are at greatest risk for lead poisoning and especially susceptible to adverse health outcomes (Schnur & John, 2014). Older housing has also been identified as a key indicator of increased lead exposure (Jacobs et al., 2002). Although the use of lead in residential paint in the United States was banned in 1978, individuals living in homes built prior to 1978 may still be exposed to lead. We anticipate these variables may affect levels of trust in government management of lead, but there is insufficient evidence to hypothesize the extent and directionality of such associations.

Trust in science

We include trust in science as a potential predictor of trust in government management of lead. Science has played an important role in determining and understanding the health and environmental risks associated with lead hazards and lead contamination. Scientific evidence informs the regulations and policies in place which serve to prevent and minimize exposures to lead. For example, in 2012, the Centers for Disease Control and Prevention (CDC) updated their stance regarding lead exposure, declaring that there was no safe level of lead exposure for children based on increasing evidence suggesting that even low levels of lead exposure can result in deleterious health effects (Vorvolakos et al., 2016). We hypothesize:

H3: Trust in science will be positively associated with trust in government management of lead.

Knowledge variables

We include two measures of knowledge: subjective knowledge and Superfund awareness. Trust is believed to be important in situations where an individual believes they do not know a lot about the issue (Siegrist & Cvetkovich, 2000). It is possible that subjective knowledge will influence levels of general trust and skepticism, particularly if an individual believes they know enough about lead. With higher subjective knowledge, an individual may feel more confident and question the effectiveness of government efforts to manage lead. We also include an item to measure if the respondent has heard of the Superfund program. The Superfund program, formally known as the Comprehensive Environmental Response, Compensation, and Liability Act, identifies and remediates hazardous waste sites in the U.S., many of which are impacted by lead contamination (US EPA, 2017). An individual who is aware of the Superfund program may place more trust in government management lead. The associated hypotheses are:

H4: Individuals with higher levels of subjective knowledge will demonstrate lower levels of trust in government management of lead.

H5: Individuals who have heard of the Superfund program will have higher levels of trust in government management of lead.

Sociodemographic variables

We also include several sociodemographic variables as controls including age, gender, race and ethnicity, income, and education. Previous results concerning the influence of sociodemographic variables on trust in government are mixed. Macoubrie (2006) found that age, gender, and race and ethnicity were not significant predictors of trust in the U.S. government to manage risks associated with nanotechnology. In contrast, Dalton (2005) found that education and age were significant predictors of trust in government, where younger and more educated individuals were more trusting of the government. Research also suggests that gender can influence political trust such that males report higher levels of trust than women (Marien & Hooghe, 2011). Lastly, we included a measure of party identification which has been demonstrated to predict confidence in a variety of different institutions (Newton & Norris, 2000). While confidence and trust have been distinguished as different concepts, it is possible the influence of both variables may be applicable to trust given their relatedness. We might expect Republicans to be less trusting of government (Cook & Gronke, 2005). Based on these findings, we hypothesize:

H6: Being male, younger, and more educated will be associated with higher levels of trust in government management of lead.

H7: Individuals who identify as Republicans will demonstrate lower levels of trust in government management of lead.

Materials and Methods

Procedure

Study procedures were approved and certified exempt by the University of Idaho Institutional Review Board (#19-159). The study was pre-tested with experts and non-experts and pilot tested using Amazon's Mechanical Turk. Feedback from both stages of preliminary review did not result in any significant changes to the survey. We distributed the final survey instrument online from December 2020 to January 2021. Eligible respondents were those at least 18 years of age and residing in the U.S. Participants were recruited online through Qualtrics' panel management service, so that they were representative of the U.S. general population in terms of age, gender, and region (Northeast, South, Midwest, and West). The regional quota prevented more populous areas overwhelming our sample. Respondents received an incentive directly from independent panel providers, however the exact amount awarded was not disclosed.

Measures

<u>Trust in government management of lead</u>

Respondents were asked to evaluate the U.S. government on different aspects of its efforts to manage lead. Eleven items, adapted from Poortinga & Pidgeon (2003), were included. The items were intended to measure general trust (competency, care, fairness, and openness) and skepticism (credibility, reliability, and integrity). All items were measured on a five-point unipolar scale, tailored to each specific item. Item wordings are shown in Table 3.1. An index variable was created by averaging the 11 items for each respondent such that each respondents had a continuous trust score.

<u>Trust in scientists</u>

Trust in science was measured in a matrix-style question where respondents were asked to consider their trust in different sources that may provide them with information related to lead and lead exposure. The question stem was "How much do you trust the following sources to provide you with accurate information about lead and lead exposure?". While the survey asked respondents to consider their trust in other sources of information, we focus here on trust in science given its role in expanding our understanding of lead and associated negative health impacts.

Knowledge

We included two measures related to knowledge: subjective knowledge and Superfund awareness. Respondents were asked to self-assess their lead-related knowledge. Eight items were used to determine a respondent's subjective knowledge. The first item considered the effects of lead on the human body and the second item asked respondents to compare their level of knowledge about the effects of lead on the human body compared to other. The remaining six items asked specifically about several issues related to lead: effects on the environment, effects on wildlife, sources of lead, how lead enters the human body, how to prevent lead exposure, and laws and regulations about lead. Respondents answered all items on a response scale from 1 = not at all knowledgeable to 5 = extremely knowledgeable. An "I don't know" option was not offered to respondents. The 8 items were averaged to create an individual subjective knowledge score. Superfund awareness was measured with the item, "Have you heard of the Superfund program?". Respondents could answer 1 = "yes" and 0 = "no".

Environmental factors

We also included two items to capture the potential influence of lead-related environmental factors on trust in government management of lead. Respondents were asked to report if there were children in the home (0 = no, 1 = yes). If "yes" was selected, they were prompted to report the age of their youngest child. Presence of children under three was recoded such that 0 = "no" and 1 = "yes". We also asked respondents if they were aware if their current place of residence was built prior to 1978 (0 = "no" or "I don't know", 1 = "yes").

Demographics

Lastly, we included several items to capture demographic information. Respondents were asked to report the year they were born and gender (male, female, and prefer not to say). Age was calculated from year of birth and treated as a continuous variable. Gender was recoded where 1 = "male" and 0 = "female". Race and ethnicity were measured with 8 categories (White alone, Black or African American, American Indian or Alaskan Native, Asian, Native Hawaiian or Pacific Islander, Hispanic or Latino, and Biracial or Multiracial). Race and ethnicity was dummy coded into 1 = "White" and 0 = "non-White". Level of education including five categories, from no high school degree to advanced degree, and income level could range from less than $20,000 to greater than $120,000. Education was dummy coded such that 1 = "At least college degree" and 0 = "Less than college degree". Income was also recoded using the median value to determine high- and low-income levels. Low income (coded 0) included respondents who reported a total annual household income from less than $20,000 up to $79,999. High income (coded 1) represented respondents with a household income of at least $80,000. Lastly, respondents were asked to report the political party they most closely identified with by answering the item "Generally speaking, do you consider yourself a Democrat, Republic, or Independent?". Respondents were also offered an "Other" option. Party identification was also dummy coded: 1 = "Republican" and 0 = "Not Republican".

Statistical analysis

We used IBM SPSS Statistical Software (Version 25) to analyze the survey data. Principal components analysis with varimax rotation was employed to test the two-factor structure of trust in government management of lead (following Poortinga & Pidgeon, 2003). We used general trust and skepticism scores to classify respondents into four trust groups based on the typology proposed by Poortinga & Pidgeon (2003). The four trust groups included distrust, acceptance, rejection, and critical trust. A median split for both general trust and skepticism allowed for creating four groups. As the median value for general trust was 3.0, the groups were classified as high general trust (≥3.0) and low general trust (<3.0). For skepticism, the median value was 3.3. The groups were classified as high skepticism (≥3.3) and low skepticism (<3.3). After classifying respondents based on their levels of general trust and skepticism, we performed a multinomial logistic regression to reveal factors that influence the classification of the four trust groups.

Results

Principal components analysis

To test Hypothesis 1, we conducted a principal components analysis (PCA) with varimax rotation. Table 3.1 shows that the PCA produced the same factor solution as that of Poortinga & Pidgeon (2003). The 11 items included to measure trust in government management of lead were described by two main components, both of which resembled results from Poortinga & Pidgeon (2003) and confirmed our hypothesis concerning the dimensionality of trust in government management of lead. The first dimension accounted for 47.6% of the variation in trust and was comprised of the items designed to measure competence, care, fairness, and openness. Consistent with previous research, this dimension (general trust) represents a general assessment of the government's efforts to manage lead risks. The second extracted factor (skepticism), which accounted for approximately 16.6% of the variation in trust in government, included items measuring credibility, reliability, and integrity. Combined, the two dimensions measuring general trust and skepticism accounted for 64.1% of the variance in trust in government management of lead.

Internal consistency

We assessed internal consistency of both constructs using Cronbach's alpha (Table 1). We used a cutoff value of 0.7 in our assessment of internal consistency, which is "appropriate for early stages of research on predictors or hypothesized measures of a construct" (Nunnally, 1978, p. 245). Based on this threshold, the general trust dimension demonstrated more than optimal internal consistency (α = .922). In contrast, the skepticism dimension demonstrated weaker internal consistency (α = .685). Removing the integrity item, "With respect to managing lead risks, how much is the government influenced by industry?", would increase the Cronbach's alpha value and meet the minimum threshold for internal consistency. However, removal of the integrity item would result in a two-factor construct so we maintained the item in the skepticism construct.

with the removal of the integrity item, "With respect to managing lead risks, how much is the government influence by industry?" (three-item α = .685; α if integrity item deleted = .737). However, the reliability was not substantially improved and it was preferable to avoid a two-item factor.

Table 3.1. Mean, standard deviation, and internal consistency of items measuring trust in government management of lead. All items began with the stem, "With respect to managing lead risks…"

Construct	Mean (SD)	General trust (reliance)	Skepticism
Competency			
How would you rate the government?	3.12 (.98)	**.745**	.070
How competent is the government?	3.07 (1.13)	**.808**	.038
How skilled are the people who work for the government?	3.18 (1.15)	**.735**	.041
Credibility			
How likely is the government to distort facts?	3.40 (1.21)	-.128	**.854**
Reliability			
How likely is the government to change policies without good reason?	3.20 (1.24)	-.008	**.807**
Integrity			
How much is the government influenced by industry?	3.67 (1.02)	-.002	**.660**
Care			
How likely is the government to act in the public interest?	3.13 (1.13)	**.819**	.036
How likely is the government to listen to concerns raised by the public?	3.00 (1.14)	**.831**	.078
How likely is the government to listen to what ordinary people think?	2.66 (1.21)	**.814**	.062
Fairness			
How fair is the government's decision-making process?	2.82 (1.15)	**.839**	.047
Openness			
How willing is the government to provide all relevant information to the public?		**.826**	.084
Eigenvalue	-	5.23	1.82
Explained variance	-	47.6%	16.8%
Cronbach's α	-	.922	.685

Note: Scales for each item were unipolar, tailored to each item, and ranged from 1: "not at all X" to 5: "extremely X".

Group classification

Table 3.2 shows the breakdown of group classification into the four trust groups. We classified 182 (17.6%) respondents in the distrust group (low general trust/low skepticism) and 316 (30.5%) respondents in the rejection group. The acceptance group included 243 respondents (23.5%) and the critical trust group accounted for 294 respondents (28.4%). Slightly more respondents (n = 610) demonstrated high levels of skepticism, while respondents were relatively evenly divided across low and high levels of general trust. Although respondents were relatively evenly distributed across the four groups, the distrust group was the smaller of the four. The χ^2 value for the group categorization was 8.1 (p <.01), which was statistically significant.

Table 3.2. Frequency and percentage of respondents in each of the four trust groups

Variables		Skepticism		
		Low	High	χ^2
General trust (reliance)	Low	Distrust group n = 182 (17.6%)	Rejection (cynicism) n = 316 (30.5%)	8.1**
	High	Acceptance (trust) group n = 243 (23.5%)	Critical trust group n = 294 (28.4%)	

Note. ** $p < .01$. Actual p-value = .003.

Sample characteristics

Table 3.3 shows the demographic breakdown of the total sample and by trust group. The demographic distributions in each group largely reflected those of the total sample, except for gender. Among the 1,035 respondents, 49.8% were women and 50.2% were male, with an average age of 46.1. There was little variation in age across the four trust groups. For gender, the distrust and rejection groups had a larger percentage of females while the acceptance and critical groups included more male respondents. Consistent with the total sample characteristics, all four groups included more non-white than white respondents. The majority of respondents had at least a college degree (36.7% college degree; 17.9% advanced degree). Respondents most frequently reported an average household income between $20,000-$49,999 (25.0%) and $50,000-$79,999 (30.6%). 44.5% of the total sample identified as a Democrat, followed by Independents (28.9%) and Republicans (23.2%).

Table 3.3. Demographic characteristics of sample by trust group

Variable		Distrust (n = 182)	Rejection (n = 316)	Acceptance (n = 243)	Critical (n = 294)	Total (n = 1035)
Age (mean)		47.1	45.5	47.1	45.3	46.1
Gender	Male	44.5%	44.9%	53.9%	54.8%	49.8%
	Female	55.5%	55.1%	46.1%	45.2%	50.2%
Race/ethnicity	White	34.6%	34.5%	39.9%	41.2%	37.7%
	Black	22.0%	13.9%	15.2%	21.1%	17.7%
	American Indian	13.2%	23.7%	15.2%	10.5%	16.1%
	Hispanic/Latino	12.6%	14.6%	15.6%	12.6%	13.9%
	Native Hawaiian	4.4%	5.7%	3.7%	4.1%	4.5%
	Biracial/Multiracial	5.5%	3.8%	4.1%	2.0%	3.7%
Education	Less than high school	2.7%	1.6%	2.5%	2.0%	2.1%
	High school graduate	22.5%	21.2%	18.9%	14.3%	18.9%
	Some college but no degree	21.4%	24.4%	29.6%	21.8%	24.3%
	College degree (2 or 4 year)	37.9%	36.4%	35.4%	37.4%	36.7%
	Advanced degree	15.4%	16.5%	13.6%	24.5%	17.9%
Income	Less than $20,000	17.6%	11.7%	13.2%	8.2%	12.1%
	$20,000-$49,999	24.7%	27.5%	24.7%	22.8%	25.0%
	$50,000-$79,999	29.1%	32.0%	28.4%	32.0%	30.6%
	$80,000-$99,999	14.8%	12.3%	12.3%	11.9%	12.7%
	$100,000 - $119,999	3.8%	5.4%	9.1%	9.5%	7.1%
	$120,000 or more	9.9%	11.1%	12.3%	15.6%	12.5%
Party identification	Republican	20.3%	23.7%	24.3%	23.5%	23.2%
	Democrat	48.9%	37.3%	44.4%	49.7%	44.5%
	Independent	28.6%	34.2%	28.0%	24.1%	28.9%
	Other	2.2%	4.7%	3.3%	2.7%	3.4%

Regression analysis

Multinomial logistic regression was used to build a predictive model for group membership – distrust, acceptance, critical trust, and rejection (reference category). The overall model with chosen predictors was significant ($\chi 2$ = 63.584, df = 33, p < .001), explaining 6.0-6.4% of the variance in group membership (Cox & Snell R^2 = .060 and Nagelkerke R^2 = .064). While a large percentage of unexplained variance remains, two significant predictor variables were identified. Having children under the age of three in the household significantly predicted membership in the distrust group relative to the rejection group (*B* = -1.207, *p* < .01, odds ratio = .299). Respondents with children under the age of three were .299 times less likely to be categorized into the distrust group when the rejection group is used as the reference category. Subjective knowledge significantly predicted membership in the critical trust group relative to the rejection group (*B* = .244, *p* < .01, odds ratio = 1.277). The odds of critical trust membership increase by more than one (OR = 1.277) for every unit increase in subjective knowledge. No significant predictors were identified to explain the likelihood of being categorized into the acceptance group relative to the rejection group.

Table 3.4. Multinomial regression results by trust group

	Distrust (n = 182) Low general trust, low skepticism		***Acceptance*** (n = 243) High general trust, low skepticism		***Critical trust*** (n = 294) High general trust, high skepticism	
Variable	*B*	Odds ratio	*B*	Odds ratio	*B*	Odds ratio
Demographics						
Age	.007	1.007	.004	1.004	-.002	.998
Gender (male)	-.049	.952	.308	1.361	.183	1.201
Race/ethnicity (white)	-.040	.961	.092	1.097	.230	1.258
Education (college)	-.017	.984	-.307	.735	.190	1.210
Income[1] (high)	.016	1.017	.310	1.364	.176	1.192
Party identification (Republican)	-.222	.801	-.026	.974	.001	1.001
Environmental						
Child under 3	-1.207**	.299	-.155	.856	-.367	.693
Pre-1978 residence	.056	1.058	-.268	.765	-.283	.754
Trust						
Trust in scientists	.003	1.003	.105	1.111	.110	1.116
Knowledge						
Superfund awareness	-.346	.707	.189	1.208	.123	1.131
Subjective knowledge	.078	1.082	.011	1.011	.244**	1.277

Note: Reference category = rejection (low general trust, high skepticism).
[1]Low includes respondents who reported a total annual household income ranging from less than $20,000 up to $79,999. High income represents respondents with a household income of at least $80,000.

Discussion

The research reported here was designed to explore trust in government management of lead in the United States. We sought to (1) determine if the typology of trust offered by Pidgeon et al. (2003) could help to classify respondents into groups based on levels of general trust and skepticism and (2) examine potential predictors influencing these classifications to understand the characteristics of each group. The results presented here lend support to the idea that different degrees of general trust can coexist with different levels of skepticism. That is, we offer quantitative evidence to support the conceptualization of trust along a spectrum of general trust and skepticism. However, our regression models explained minimal variance in our response variable (trust in government management lead as a function of general trust and skepticism). Our classification showed that the rejection group (30.5%) had the highest number of respondents. The critical trust (28.4%) and acceptance (23.5%) groups were similar in size, followed by the distrust group (17.6%). This classification indicates that slightly more than half of all respondents (combined 58.9%) in rejection and critical trust groups) reported high levels of skepticism, reflecting skeptical views regarding how lead-related policies are enacted and upheld. Respondents were more equally distributed between low and high levels of general trust, which reflects a variety of positively worded trust-relevant concepts including competence, care, fairness, and openness.

Factors that predict trust group membership were identified albeit in short supply. Respondents who indicated having at least one child under the age of three in their household were more likely to be categorized in the rejection group than the distrust group. The primary difference between these two groups is the level of skepticism, such that members of the rejection group exhibit higher levels of skepticism with regards to government efforts to manage lead hazards. Given that children are more vulnerable to lead exposure and associated health risks, it is reasonable to expect parents of young children to be more skeptical of government efforts to manage lead hazards when their child's health is at risk. We also found subjective knowledge about lead to be a significant predictor in the model such that individuals who believe themselves to have sufficient knowledge related to lead are more likely to be categorized into the critical trust group relative to the rejection group. That is, respondents with high levels of subjective knowledge demonstrate higher levels of general trust as members of the critical trust group. Higher levels of general trust indicate a confidence in government competency, care, fairness, and openness with regards to lead management. This result may suggest that respondents who feel they possess sufficient lead-related knowledge are more willing to trust that the government is well-intentioned in their efforts to manage lead. It could also indicate a broader disengagement from the issue of lead entirely. Lastly, the predictor variables included in this model did not distinguish between membership in the acceptance group relative to the rejection group.

We found no sociodemographic variables to be statistically significant predictors of group membership. Political party identification did not significantly predict group membership, suggesting trust in government management of lead is not a politically divisive issue. This insight is valuable from a risk communication standpoint in that specific messaging or information channels based on party identification may not be necessary. We expected trust in science and Superfund awareness to be positively and significantly associated with trust in government. Scientific evidence is at the core of lead-related regulations. Similarly, the Superfund program is promulgated by a science-forward government agency, the Environmental Protection Agency (EPA).

This study has several practical implications for lead-related policy and education. First, this study explored the use of the Pidgeon et al. (2003) typology of trust as a framework for characterizing national trust in government management of lead. The applicability of this typology to the context of lead risk management was confirmed in this study. This suggests that this framework could be a valuable tool for targeting risk communication and educational efforts to specific segments of the population. The results from this study also identify a limited set of characteristics of each group that can be used to tailor information campaigns related to lead.

This study aimed to identify sociodemographic, environmental, trust, and knowledge factors that predict group membership, yet we only found having children under three and subjective knowledge to be significant predictors. Further research is needed to better characterize group membership. Additionally, the distribution of respondents across categories may have masked other significant results. This typology of trust would offer more poignant insight had group membership been used to predict support for lead-related policy, for example. Our results here are largely descriptive, although we lay a foundation for the critical examination of trust in government within the context of lead risk management, a concept that has been understudied at the national level. Lastly, we also asked about trust in government during a presidential transition which may have affected judgements of trust as the political environment has been shown to influence trust (Bouckaert & Van de Walle, 2003; Hetherington, 1998). It has also been shown that in times of crisis, such as in the midst of a global pandemic, trust measured in surveys may be overstated (Intawan & Nicholson, 2018)

Conclusion

This study classified different respondents by applying a typology of trust offered by Pidgeon et al. (2003), considering trust in government as a function of levels of general trust and skepticism. We identified four types of groups – distrust, acceptance, critical trust, and rejection – and examined predictors of group membership using multinomial logistic regression. This research provides implications for designing risk communication messages, policies, and segmentation of U.S. citizens pertaining to lead. Future research should examine how these four types of trust influence public engagement and the acceptance or rejection of public policies related to lead.

Conclusion

This study classified different respondents by applying a typology of trust offered by Pidgeon et al. (2003), considering trust in government as a function of levels of general trust and skepticism. We identified four types of groups – distrust, acceptance, critical trust, and rejection – and examined predictors of group membership using multinomial logistic regression. This research provides implications for designing risk communication messages, policies, and segmentation of U.S. citizens pertaining to lead. Future research should examine how these four types of trust influence public engagement and the acceptance or rejection of public policies related to lead.

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Chapter 4: Conclusion

Lead in the environment is ubiquitous (Lanphear et al., 2018). Regulations to mitigate lead hazards in the U.S. have greatly reduced blood lead levels (Bellinger et al., 2017), but lead remains a contemporary public health issue. Past research has focused on at-risk population subgroups and specific areas with high levels of contamination. As a result, perceptions of lead at the national scale are unknown. Examining public perceptions of lead can help characterize the degree to which citizens support efforts to manage lead risks. Public support ensures funding for existing public health and environmental management programs to remove or contain lead contamination and protect collective health.

This research sought to establish an initial understanding of public perceptions of lead in the U.S. using a national online survey of U.S. residents (n = 1,035). In the first chapter, I aimed to understand how the public perceives the risk of lead exposure. More specifically, I examined how the risk of lead exposure compares to other common environmental risks. I also explored the relationships between trust in government management of lead, subjective knowledge about lead, and the perceived risk of lead exposure. Results indicated that lead exposure does not raise concern among the general U.S. public. Respondents were more concerned with the risks from air pollution, water pollution, and habitat loss than with the risk of lead exposure. I also found that both trust in government management of lead and subjective knowledge about lead significantly predicted perceptions of lead exposure risk. Lastly, I explored the potentially moderating influence of subjective knowledge on the relationship between trust and perceived risk. In contrast to previous research, my findings demonstrated that respondents who believe to be knowledgeable about lead also showed increased levels of trust in the government management of lead and perceived risk of lead exposure.

In my second chapter, I further investigated trust in government management of lead by categorizing respondents into four different groups – rejection, distrust, critical trust, and acceptance – based on levels of reliance and skepticism. Most respondents exhibited high levels of skepticism in government management of lead but were almost equally distributed between high and low levels of reliance. We identified a limited set of characteristics that predict group membership but lay a foundation for future research to further examine trust in government management of lead.

This research provides an initial foundation upon which to further our understanding of perceptions of lead exposure risk in the U.S. Future research should consider 1) expert and government assessments of risk, 2) comparative analyses, and 3) experimental designs. Examining perceptions of risk among experts and government officials could identify potential perception gaps between risk management authorities and the public. It is generally assumed that experts and the public are often at odds in their assessments of risk. However, no empirical evidence currently exists to support or deny the existence of such a perception gap in the context of lead. Ensuring perceptions of risk across stakeholder groups are congruent could lead to more efficient and effective strategies for risk management.

Comparative analyses can also offer enlightening insight. Exploring national and regional perspectives in tandem could increase our understanding of the issue saliency of lead exposure. Another approach to comparative analyses could explore perceptions of lead in other countries, including developed and developing countries. A comparison between the U.S. and other developed countries could allow for mutual learning and lead to a more concerted effort to reduce lead exposures. Future studies could also examine perceptions of lead exposure in developing countries, where the risk of exposure is generally considered to be higher due to a lack of regulation and continued industrial activities. Comparisons between developed and developing countries could help translate strategies that have effectively reduced exposures in developed countries into approaches suited to the context of developing countries.

Lastly, the use of experimental designs can offer more tangible recommendations for risk communication efforts. This approach is frequently used to test the effectiveness of different messaging techniques for a variety of different health-related outcomes, such as policy development or behavior change. For example, a future study could use an experimental design to examine support for lead-related policies by exposing respondents to different message conditions to ascertain whether a specific message increases or decreases support for policy implementation. Results from such study designs can be more directly applied in a real-world context to tailor future risk communication strategies or efforts to obtain policy support from the public.

To many, the issue of lead exposure is, in fact, not an issue. Yet, localized incidents such Flint, Michigan, demonstrate that 1) the risk of lead exposure persists and 2) can be challenging to uncover and address. This research offers a unique perspective on the issue of lead exposure in the U.S. The results presented here can be applied to tailor risk communication strategies, develop educational interventions, and inform lead-related policymaking. In the long run, lead risk management requires support from more than those populations most at risk. Widespread support is crucial for ensuring existing policies remain in effect and paving the way for future regulations to aid in the prevention and management of lead in the environment.

Appendix A

Public Perceptions of Lead in the United States

Informed Consent

We are researchers from the College of Natural Resources at the University of Idaho conducting a research study. The purpose of this research is to better understand what the general public thinks and knows about the potential risks of lead exposure. Lead occurs naturally in the environment in small amounts but has also been used in a variety of different industrial processes and consumer products. As a result, exposure to lead remains a public health risk. You are being asked to participate in this study because you are at least 18 years of age and a resident of the United States. Your participation will involve answering a series of questions regarding what you think and know about lead risks in the United States. The survey should take 15-20 minutes to complete. Please answer the questions to the best of your ability. There are no right or wrong answers, and you have the right to withdraw at any time. This study has been reviewed and meets research assurance standards, including protection of privacy and confidentiality, by the University of Idaho's Institutional Review Board (IRB). This means that your survey responses will not be linked to any identifying information. If you have any questions about this research project, please contact Madeline Goebel (mgoebel@uidaho.edu) or Dr. Chloe Wardropper(cwardropper@uidaho.edu). If you have any concerns about your rights as a participant, please feel free to contact the University of Idaho IRB at irb@uidaho.edu or 208-885-6340.

Thank you in advance for your participation!

Sincerely,

Dr. Chloe Wardropper Madeline Goebel


By continuing with the survey, you confirm that you are 18 years old or older and consent to participate.

Thank you for your interest in our study! Before you get started, please answer the following questions to determine if you meet the demographic criteria for our study.

What year were you born?

____

What is your gender?

- Male
- Female
- Prefer not to say
- Other ______

Which of the following racial or ethnic groups do you most closely identify with?

- American Indian or Alaskan Native
- Asian
- Black or African American
- Hispanic or Latino
- Native Hawaiian or Pacific Islander
- White
- Biracial or Multiracial

What is your total annual household income, before taxes?

- Less than $50,000
- $50,000-$59,000
- $60,000-$69,000
- $70,000 or more

What state do you live in?

Alabama	Georgia	Maine	Nevada	Oregon	Virginia
Alaska	Hawaii	Maryland	New Hampshire	Pennsylvania	Washington
Arizona	Idaho	Massachusetts	New Jersey	Rhode Island	West Virginia
Arkansas	Illinois	Michigan	New Mexico	South Carolina	Wisconsin
California	Indiana	Minnesota	New York	South Dakota	Wyoming
Colorado	Iowa	Mississippi	North Carolina	Tennessee	
Connecticut	Kansas	Missouri	North Dakota	Texas	
Delaware	Kentucky	Montana	Ohio	Utah	
Florida	Louisiana	Nebraska	Oklahoma	Vermont	

INSTRUCTIONS: Please answer every question by marking one box or filling in the blank as instructed. You may notice that there is no "I don't know" response to many of the questions in this survey. If you are unsure about how to answer, please respond to the best of your ability. There are no right or wrong answers.

The following questions ask you to report how much you know about lead and lead exposure. We recognize that you may not know a lot about lead, but we want to understand your baseline knowledge. Later in the survey, we will provide you with more information about lead and lead exposure.

How would you rate your own knowledge about the impact of lead on the human body?

- Not at all knowledgeable
- Slightly knowledgeable
- Somewhat knowledgeable
- Moderately knowledgeable
- Extremely knowledgeable

Compared to other people, how would you rate your own knowledge about the impact of lead on the human body?

- Not at all knowledgeable
- Slightly knowledgeable
- Somewhat knowledgeable
- Moderately knowledgeable
- Extremely knowledgeable

How knowledgeable do you think you are about the following issues related to lead?

	Not at all knowledgeable	Slightly knowledgeable	Somewhat knowledgeable	Moderately knowledgeable	Extremely knowledgeable
a. Effects on the environment	○	○	○	○	○
b. Effects on wildlife	○	○	○	○	○
c. Sources of lead	○	○	○	○	○
d. How lead enters the human body	○	○	○	○	○
e. How to prevent lead exposure	○	○	○	○	○
f. Laws and regulations about lead	○	○	○	○	○

Please read the following information about lead and lead exposure.

Lead and its uses
Lead (Pb) is a metal that occurs naturally in the earth's crust in small amounts. Human activity, such as mining and manufacturing, have caused it to become more widespread. Lead was once used in paint and gasoline, and is still used in some consumer products like batteries or pipes. As a result, lead can be found in all parts of our environment, including air, soil, and water, and even inside our homes.

Lead exposure
While lead has some beneficial applications, it can also be toxic to humans, animals, and the environment. Lead most commonly enters the human body through inhalation or ingestion of contaminated materials, but is generally odorless and tasteless. Lead can affect almost every organ and system in the human body. Pregnant women and children are most at risk of experiencing negative health effects. However, there is no safe level of lead exposure.

Lead management
In the United States, regulations have helped to reduce lead exposure. Congress has passed a number of laws related to lead. For example, lead has been banned from household paints in the United States since 1978, but older homes may still have lead-based paint. There are also regulations in place to reduce lead emissions from industrial activities and government programs to help manage lead waste. Despite these efforts, lead risks remain.

By selecting "yes", I confirm that I have read the above information about lead and lead exposure.

- Yes

The following questions will ask you to consider your level of concern with regards to lead exposure.

How concerned are you (if at all) about the potential negative effects of lead exposure?

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Moderately concerned
- Extremely concerned

Considering any potential effects that being exposed to lead might have on you personally, how concerned are you about exposure to lead?

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Moderately concerned
- Extremely concerned

Considering any potential effects that being exposed to lead might have on others, how concerned are you about exposure to lead?

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Moderately concerned
- Extremely concerned

The following questions will ask you to consider different feelings you might experience when you think about lead and lead exposure.

When you think about being exposed to lead, to what extent do you feel fearful?

- Not at all fearful
- Slightly fearful
- Somewhat fearful
- Moderately fearful
- Extremely fearful

When you think about being exposed to lead, to what extent do you feel anxious?

- Not at all anxious
- Slightly anxious
- Somewhat anxious
- Moderately anxious
- Extremely anxious

When you think about being exposed to lead, to what extent do you feel worried?

- Not at all worried
- Slightly worried
- Somewhat worried
- Moderately worried
- Extremely worried

The next questions ask you to consider your likelihood of being exposed to lead. We realize these questions may be challenging, but answer to the best of your ability.

In the coming year, how concerned are you about being exposed to lead where you live?

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Moderately concerned
- Extremely concerned

In the coming year, how confident are you that you will not be exposed to lead where you live?

- Not at all confident
- Slightly confident
- Somewhat confident
- Moderately confident
- Extremely confident

In the past year, how often do you think have you been exposed to lead?

- Almost never
- Rarely
- Sometimes
- Often
- Frequently

The following questions ask you to consider the nature of impacts you might experience from lead exposure.

If you were exposed to lead, how severe of an impact would it have on you personally?

- Not at all severe
- Slightly severe
- Somewhat severe
- Moderately severe
- Extremely severe

How severe are the impacts of lead exposure to you?

- Not at all severe
- Slightly severe
- Somewhat severe
- Moderately severe
- Extremely severe

If you were exposed to lead, how devastating would the impacts be?

- Not at all devastating
- Slightly devastating
- Somewhat devastating
- Moderately devastating
- Extremely devastating

What color is the sky? Please select pink to show you are paying attention.

- Blue
- Green
- Gray
- Pink

The following questions ask you to consider how vulnerable you think you are to the negative impacts of lead exposure.

If you were exposed to lead today, how likely is it that you would experience negative impacts?

- Not at all likely
- Slightly likely
- Somewhat likely
- Moderately likely
- Extremely likely

How protected would you feel if you were exposed to lead?

- Not at all protected
- Slightly protected
- Somewhat protected
- Moderately protected
- Extremely protected

How likely is it that you would be negatively impacted if exposed to lead?

- Not at all likely
- Slightly likely
- Somewhat likely
- Moderately likely
- Extremely likely

How likely is it that your family would be negatively impacted if exposed to lead?

- Not at all likely
- Slightly likely
- Somewhat likely
- Moderately likely
- Extremely likely

How likely is it that your property would be negatively impacted if exposed to lead?

- Not at all likely
- Slightly likely
- Somewhat likely
- Moderately likely
- Extremely likely

In your opinion, what is the risk of negative impacts from lead exposure for each of the following?

	No risk	Low risk	Moderate risk	High risk	Very high risk
a. Yourself	○	○	○	○	○
b. Friends and family	○	○	○	○	○
c. Your community	○	○	○	○	○
d. Your state	○	○	○	○	○
e. The United States	○	○	○	○	○
f. Developing countries	○	○	○	○	○
g. The world	○	○	○	○	○

In your opinion, how risky are the following environmental issues?

	Not at all risky	Slightly risky	Somewhat risky	Moderately risky	Extremely risky
a. Air pollution	○	○	○	○	○
b. Climate change	○	○	○	○	○
c. Pollution of rivers and lakes	○	○	○	○	○
d. Exposure to lead	○	○	○	○	○
e. Habitat loss	○	○	○	○	○

While lead does occur naturally in small amounts, it is also produced as the result of various industrial activities and can enter into our water, soil, and air. Considering potential exposure, how dangerous do you think each of the following sources of lead are to your health?

	Not at all dangerous	Slightly dangerous	Somewhat dangerous	Moderately dangerous	Extremely dangerous
Industrial processes and waste	○	○	○	○	○
Mining and smelting activities	○	○	○	○	○
Lead air pollution	○	○	○	○	○
Lead in drinking water	○	○	○	○	○
Lead in soil	○	○	○	○	○
Lead in dust	○	○	○	○	○

Lead has also been used in a wide variety of consumer products. Considering potential exposure, how dangerous do you think each of the following sources of lead are to your health?

	Not at all dangerous	Slightly dangerous	Somewhat dangerous	Moderately dangerous	Extremely dangerous
Lead-contaminated food products (including produce grown in home soil)	○	○	○	○	○
Lead-contaminated consumer products (e.g. makeup, children's toys)	○	○	○	○	○
Lead-based paint	○	○	○	○	○
Lead in cigarettes	○	○	○	○	○
Lead in gasoline	○	○	○	○	○
Lead-based ammunition	○	○	○	○	○

While multiple government agencies work on reducing the risk of lead exposure, please think about the collective efforts of the government as a whole. You will be asked to judge various aspects of the government's performance as it relates specifically to managing lead risks in the United States.

How would you rate the government at managing lead risks?

- Terrible
- Poor
- Average
- Good
- Excellent

With respect to managing lead risks, how competent is the government?

- Not at all competent
- Slightly competent
- Somewhat competent
- Moderately competent
- Extremely competent

With respect to managing lead risks, how skilled are the people who work for the government?

- Not at all skilled
- Slightly skilled
- Somewhat skilled
- Moderately skilled
- Extremely skilled

With respect to managing lead risks, how likely is the government to distort facts?

- Not at all likely
- Slightly likely
- Somewhat likely
- Moderately likely
- Extremely likely

With respect to managing lead risks, how likely is the government to change policies without good reason?

- Not at all likely
- Slightly likely
- Somewhat likely
- Moderately likely
- Extremely likely

If you have read this question carefully, please select "Extremely attentive".

- Not at all attentive
- Slightly attentive
- Somewhat attentive
- Moderately attentive
- Extremely attentive

With respect to managing lead risks, how much is the government influenced by industry?

- None at all
- A little
- A moderate amount
- A lot
- A great deal

With respect to managing lead risks, how likely is the government to act in the public interest?

- Not at all likely
- Slightly likely
- Somewhat likely
- Moderately likely
- Extremely likely

With respect to managing lead risks, how likely is the government to listen to concerns raised by the public?

- Not at all likely
- Slightly likely
- Somewhat likely
- Moderately likely
- Extremely likely

With respect to managing lead risks, how likely is the government to listen to what ordinary people think?

- Not at all likely
- Slightly likely
- Somewhat likely
- Moderately likely
- Extremely likely

With respect to managing lead risks, how fair is the government's decision-making process?

- Not at all fair
- Slightly fair
- Somewhat fair
- Moderately fair
- Extremely fair

With respect to managing lead risks, how willing is the government to provide all relevant information to the public?

- Not at all willing
- Slightly willing
- Somewhat willing
- Moderately willing
- Extremely willing

With respect to managing lead risks, how similar are your opinions and the government's opinions?

- Not at all similar
- Slightly similar
- Somewhat similar
- Moderately similar
- Extremely similar

With respect to managing lead risks, how similar are your ideas and the government's ideas?

- Not at all similar
- Slightly similar
- Somewhat similar
- Moderately similar
- Extremely similar

Preventing and reducing lead exposure requires joint effort across federal, state, and local governments. How much trust do you place in federal, state, and local government to effectively manage lead risks in the United States?

	Not much trust	A little trust	Some trust	A moderate amount of trust	A great deal of trust
Federal government	○	○	○	○	○
State government	○	○	○	○	○
Local government	○	○	○	○	○

Did you have trouble distinguishing between federal, state, and local government in the previous question?

- Yes
- No

How much do you trust the following sources to provide you with accurate information about lead and lead exposure?

	Not much trust	A little trust	Some trust	A moderate amount of trust	A great deal of trust
a. Friends	○	○	○	○	○
b. Family	○	○	○	○	○
c. Doctors	○	○	○	○	○
d. Scientists	○	○	○	○	○
e. Government officials	○	○	○	○	○

How sufficient are the current rules and regulations at controlling lead risks?

- Not at all sufficient
- Slightly sufficient
- Somewhat sufficient
- Moderately sufficient
- Extremely sufficient

How confident are you that lead risks are being adequately regulated?

- Not at all confident
- Slightly confident
- Somewhat confident
- Moderately confident
- Extremely confident

Have you heard of the Superfund program?

- Yes
- No

Are you aware of any Superfund sites in your county?

- Yes
- No
- I don't know

Do you have a child/children?

- Yes
- No

What is the age of your youngest child?

____

Do you use Medicaid for health insurance coverage?

- Yes
- No
- I don't know

Has your child/children ever been tested for blood lead levels?

- Yes
- No
- I don't know

Have you personally ever had high blood lead levels?

- Yes
- No
- I don't know

Has a friend or family member ever had high blood lead levels?

- Yes
- No
- I don't know

Are you exposed to lead at your place of work?

- Yes
- No
- I don't know

Do you own your home?

- Yes
- No

Was your current place of residence built prior to 1978?

- Yes
- No
- I don't know

Regarding tobacco products, which of the following best describes you?

- I use them regularly
- I use them occasionally
- I used to use them but stopped
- I have never used them

Do you participate in recreational shooting activities?

- Yes
- No

Do you make your own ammunition?

- Yes
- No

Finally, we have a few more questions about you and your household. This information will be used only in summary form to compare survey responses across demographic groups.

Are you currently pregnant?

- Yes
- No

What is your total annual household income, before taxes? Although we asked about this earlier in the survey, we would also like a more accurate estimate.

- Less than $20,000
- $20,000-$49,999
- $50,000-$79,999
- $80,000-$99,999
- $100,000-$119,999
- $120,000 or more

What is the highest level of school you have completed or the highest degree you have received?

- Less than high school degree
- High school graduate (or equivalent)
- Some college but no degree
- College degree (2 or 4 year)
- Advanced degree (Master's, PhD, JD, MD, etc.)

Prior to the COVID-19 pandemic, what was your occupational status?

- Homemaker
- Retired
- Student
- Unemployed
- Working part-time
- Working full-time
- Other (please specify):______________

Including yourself, how many people currently live in your household?

____

Which of the following categories best describes your political views?

- Strongly conservative
- Somewhat conservative
- Moderate
- Somewhat liberal
- Strongly liberal

Generally speaking, do you consider yourself a Democrat, Republican, or Independent?

- Democrat
- Republican
- Independent
- Other ____________

Thank you for taking the time to fill out our survey! You have provided us with valuable information that will help researchers, policymakers, and decisionmakers understand what the general public thinks and knows about lead. We appreciate your participation.

If you have any additional comments on the survey or about lead exposure in general, please comment below.

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