

Community Views About the Health and Exposure of Children Living Near a Coal Ash Storage Site

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Abstract Coal ash, a waste product generated from burning coal, is composed of small particles comprised of highly toxic elements. Coal ash particles contain heavy metals such as arsenic, lead, and mercury, as well as polyaromatic hydrocarbons and radioactive elements. Most coal ash is stored in landfills and ponds, often located in close proximity to low income communities. Currently, there are no federal regulations governing the storage and transport of coal ash; however the Environmental Protection Agency proposed a coal ash rule in 2010, which could designate coal ash as a hazardous waste. This is the first article to assess community impact from coal ash storage, by exploring parents' perceptions of their children's health and its relationship to chronic exposure to coal ash. This was a community-based study involving four neighborhoods adjacent to a large coal ash storage facility. Focus groups were conducted with community members and the transcripts were analyzed to identify themes regarding children's health, children's exposure to coal ash, and behaviors done to protect children from exposure. The majority of parents (85 %) reported that their children suffered from health conditions; specifically respiratory and emotional and behavioral disorders. Parents highlighted ways in which their children were exposed to coal ash, although many felt they were constantly exposed just by living in the area. Parents felt strongly that exposure to coal ash from the landfill is affecting the health and well-being of their children. Some parents attempted protective behaviors, but most parents felt helpless in reducing children's exposure.

Keywords Children · Illness and disease · Environment · Coal ash · Focus groups

Introduction

In 2012 in the United States, coal-fired power plants were responsible for producing 110 million tons of coal combustion residuals, commonly referred to as coal ash [1]. The majority of coal ash is stored in landfills and slurry ponds, often located in close proximity to low income communities. It is estimated that there are approximately 300 landfills and 584 ash ponds in use throughout the United States, although the actual number may be much greater [2]. The toxicity of ash varies based on the geochemical properties of the coal being burned and the method of burning; however, coal ash frequently contains heavy metals, including arsenic, mercury, lead, cadmium, polycyclic aromatic hydrocarbons (PAHs), and radioactive elements [3–12]. Many of the components found in coal ash are neurotoxins, carcinogens, teratogens, and mutagens.

The predominate component of coal ash is fly ash (60–70 %), which consists of small, spherical particles with diameters predominately $\leq 10 \mu\text{m}$ (PM_{10}) [6, 9, 13, 14]. These small particles have the potential for being highly hazardous, as they have the ability to penetrate deep into the lungs and enter the bloodstream. Furthermore, as particle size decreases, the surface area and pollutant concentration increases. Spencer and Drake [15] found that the concentration of metals in fly ash can be two times greater than the concentration found in the coal.

Under Subtitle D of the Resource Conservation and Recovery Act (RCRA), coal ash is classified as a non-hazardous solid waste, therefore coal ash can be stored in open-air impoundments and landfills. Based on this

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classification, the federal government does not regulate coal ash, instead each state is responsible for regulation, although state requirements are frequently non-existent or minimal [16, 17].

Growing concern about the impact of coal ash exposure on health led the Environmental Protection Agency (EPA) to propose a coal ash rule in June 2010 [16]. The rule contains two distinct options for regulation under RCRA: (1) under Subtitle C, coal ash would be considered a “special waste” and be subject to federal regulations and enforcement regarding handling, storage, disposal, and transport, or (2) under Subtitle D, which would regulate coal ash as “non-hazardous waste” but develop national standards for constructing and monitoring storage facilities. These standards would regulate location of storage facilities, composite liner requirements, groundwater monitoring, and actions taken to address emissions from the unit. To date, no decision has been made on the rule.

Fugitive coal ash dust emissions from landfills and ponds pose a potentially hazardous chronic exposure. Although the toxicity and hazard potential of coal ash exposure is high, there is limited research on the health effects of coal ash exposure. The majority of studies are animal, occupational, or studies assessing impact from power plant stack emissions [18–25]. Studies have reported that children exposed prenatally to coal ash from stack emissions containing PAHs and lead had decreased motor, language, and social development [23, 25]. To date, there is no published research investigating the impact of coal ash on communities residing near coal ash landfills and ponds.

In order to understand the impact of coal ash from landfills and ponds on children, we worked with four neighborhoods adjacent to a large coal ash storage facility. Since children are a highly vulnerable population with unique exposure behaviors, the objectives were to explore parents’ perceptions of their children’s health and its relationship to chronic exposure to coal ash. In this article, three questions are addressed: What is the impact of coal ash on community and quality of life? How are children exposed and what is done to reduce exposure? and What is the impact of coal ash on children’s health and well-being?

Methods

This was a community-based research design working with residents of four neighborhoods adjacent to a large coal-burning power plant. The power plant has been the center of neighborhood concern for years; with residents claiming that coal ash from the landfill and ponds blows into their yards, cars, and homes, and is made airborne when trucks drive around on site, or move piles on the landfill or into the ponds. Neighbors complain of increased health conditions. In 2012,

five focus groups with 26 adult community members were conducted. All study procedures were approved by the Institutional Review Board of the University of Louisville.

Description of Site

The 58-year old coal-burning power plant is located in Kentucky, which ranks 5th in the US for coal ash generation and has the 3rd largest coal ash storage capacity in the country [26]. The plant encompasses over 500 acres including a large ash landfill and multiple ash ponds. The landfill, which was opened in 1982, stores a mix of coal ash products on 163 acres. In summer 2012, the plant was fined for 13 violations associated with fugitive dust and odors. The main ash pond, which stores fly ash and bottom ash, was opened in 1972 and is 40 acres in size with a dam height of 12 feet. In 2009, this pond was rated as a “high-hazard” by the EPA, suggesting that if the dam were to fail, loss of human life or damage to homes or buildings may result. State regulations require that “high hazard” ponds be inspected every 2 years.

Description of Community

The community consists of two large single-family home subdivisions and two mobile home parks, located within a mile radius of the plant. Some residents live within 50 yards of the landfill and directly across the street from the high-hazard pond. Five schools (2 elementary, 1 middle, 1 K-8 special needs, and 1 high school) are located within one mile of the plant. The population is predominately low-income, multi-generational, non-transient, and white. The median household income of these communities is \$32,832, compared with that of Kentucky which is \$40,061. While many of the residents are concerned about the coal ash, they are also fearful of repercussions if they speak out.

Community Leaders and Engagement

In September 2011, research team members began meeting with residents of the community who were known for being active in environmental justice issues. In May 2012, eleven of the community members assumed roles as community leaders. The community leaders were predominately long-term residents of the neighborhoods ranging in age from 37 to 65 year old. In partnership with us, they agreed to help recruit their neighbors, review study materials, and discuss results. In May of 2012, study team members and community leaders went door-to-door handing out fliers, talking with residents, and encouraging them to attend upcoming community-wide meetings.

In June 2012, two community-wide meetings were held at a local restaurant. The restaurant was a well-established location in the community and had private facilities where we introduced the study, talked about participating in the focus groups, and answered questions.

Focus Groups

Five focus groups with 26 adults were conducted in July and August 2012. Two of the five groups were same gender groups, although this was not planned. For these two groups, scheduled male participants did not attend, thus the groups were female only. Three of the focus groups were conducted by the PI of the study who has focus group and interview experience with both adults and children. Two of the focus groups were co-conducted by the PI and a doctoral student with background in health education. A semi-structured guide was used that contained three sections—(1) community strengths and weaknesses, (2) perceptions and beliefs about coal ash and exposure, and (3) perceptions about community health and personal/family health. The discussions were taped and two additional study team members took notes regarding the conversation and dynamics of the group. The shortest group lasted 50 min and the longest group lasted 1.5 h. At the end of the group, each participant completed a questionnaire that asked about length of time in the community, health, children's health, smoking history, and activities related to exposure such as time spent outside, amount of time windows opened, etc. Participants received a \$10 gift card at the end.

Of the 26 focus group participants, 16 (62 %) were female and 10 were male (38 %). The average age of all participants was 51.3 years (SD = 13.9). Males were slightly older than females [55.5 years old (SD = 10.1) vs. 48.4 years old (SD = 15.3; $p < 0.05$)]. The majority of participants (62 %) lived in their current home for more than 20 years. Less than half the participants worked full-time (46 %). Some were retired (23 %) or unable to work (15 %). Most (77 %) had children. Of those with children, 85 % reported that their children had specific health problems.

Analysis of Transcripts

The focus groups were transcribed verbatim and we compared the text with the notes for consistency. Since there are no studies on populations chronically exposed to coal ash, we analyzed the focus group data using inductive thematic analysis [27, 28]. This method allows for themes to emerge from the data, without fitting data into a pre-existing coding frame, or the researcher's analytic preconceptions. To establish the themes, four study team members read the transcripts multiple times and individually coded the data

according to ideas that came from the discussions with community members. Afterwards we met to reach agreement on emergent themes that occurred both within groups and across groups. Once the main themes were identified, the transcripts were reviewed for additional assignment of coded text to the thematic areas.

Results

Community Issues and Quality of Life

The participants spoke fondly of their neighborhoods and community. Many grew up and stayed within the area. They felt safe, knew their neighbors and “watched the kids grow up.” Although a sense of community was strong and residents liked many aspects of life in their neighborhoods, all participants mentioned quality of life being impacted by the coal ash landfill and storage ponds. All residents claimed to see the ash come directly from the landfill: As one woman stated:

The stuff I see is actually the coal ash on the mountain, whatever you want to call it. I call it a dump. You can actually, when the wind is blowing hard enough, you can see it, it flies and it comes right to- when the wind's blowing our way, it's right on top of our head.

Common themes related to the impact of the coal ash storage site included: the height of the landfill hiding the view of the river and Indiana, the smell of the ponds, and the dirty ducks, homes and cars. Many residents reminisced about the view across the river—“You used to be able to see Indiana on {named} Road. Now, you got ash now. You got cinder mountain sitting in front of you.” A 52-year old female who lived in the neighborhood for more than 30 years summed her situation up with an example:

Two years ago, I have relatives come up from South Carolina. We sit on my front porch and we watched the fireworks, 4th of July fireworks from Caesar's over in Indiana. We cannot see that anymore because of that ugly hill that's been put up there.

One of the most commonly reported quality of life problem was the dirtiness associated with coal ash. Dirtiness from fugitive dust from landfill ash and dirtiness from the slurry that is transported by ducks and geese. Residents talked about ducks and geese who swim in the ponds dropping coal ash on their porches, roofs, and yards “they come walking over and they're black and underneath them even. We've seen their little feet. I've got pictures where they've come up on my front porch.” Others talked about the ash on cars, homes, roofs, toys, and pools:

No, we can't enjoy our pool or nothing because it's all black film on it, on the pool and everything, so we haven't opened it for this year and everything because we don't want our grandchildren and them to get in it... It's all on top of our cars and our homes and everything up on top the roofs and everything, a black film stuff.

Many residents expressed fear and concern about what would happen should the landfill or pond give way.—“That ash hill, it just gets taller and taller. If that thing gave way, we'd be in trouble. There would be no reaction time. It would cover our whole neighborhood, I think.” Several participants reflected on the coal ash spill in Tennessee and described how they are in the same situation or worse, because they live in a flood plain.

Most participants lived in the community their entire lives. While the negatives of the community outweigh the positive, residents simply cannot move; property values have decreased and people are not buying homes in these neighborhoods. One resident best summed up their situation as:

The only way that you can completely prevent yourself from it is to move, move out of the area. But, like we're saying earlier, unfortunately, a lot of people can't because of financial reasons or because nobody wants to buy the home. What would you do?

One woman summed up everyone's thoughts as “we're trapped.”

Children's Exposure

All focus group participants but one believed that children were definitely exposed to coal ash. During the discussions, participants talked about how they knew children were exposed and what behaviors, if any, they did to protect their children. When asked how children were exposed, residents described modes of exposure such as ingestion, and provided descriptive proof of exposure. Parents described the “black mess and black specks” that children get when playing outside: “The kids go out and run around in the grass barefooted and their bottoms of their feet will become plumb black mess,” and

We've got one of our little grandsons living at our home and I know that after he's outside playing and everything, when he comes into get his bath at night, in our tub when they go to let the water out it's black specks all in the tub...

Other parents summed up the ash being on play items, like toys and swing sets. One woman who lived in her neighborhood for more than 25 years stated:

I have, what, at least a \$500.00 swing set in my side yard. It's got the bright yellow tubes and the slide and everything. Every three months, you have to get out there with chlorine bleach and clean that thing off. My granddaughter can slide down it and you can see it on the seat of her pants. If it's on the seat of her pants, it's on her hands because they go down it with their hands.

Many parents basically summarized all activities, implying that no-where was safe from coal ash exposure: “Playing on it. Out in the grass, playing basketball. Going back and forth to the school bus, going to school, walking to their friend's house, walking to the little corner store, breathing it...”

Exposure-Reducing Behaviors

One of the major themes that arose from discussions was that parents believed there was nothing that could be done to protect their children from coal ash exposure, although several parents mentioned limiting time outside for younger children. As one mother said: “I'm not going to let my kids play in the front yard with that, whatever it is on their toys. I'll clean it off the next day, it's just the same thing,” and “We rarely play outside because I'm afraid to take my boy outside, the pollution in the air is going to cause him to get sick.”

Health Conditions in Children

When asked about their children's health, 85 % of focus group parents reported having a child with a health condition. Results from focus groups highlighted respiratory conditions and emotional, behavioral, and learning disorders as affecting children in coal ash neighborhoods. Every focus group perceived asthma, breathing problems, ADHD, and autism as being conditions that impacted children in the neighborhoods. Respondents perceived that most children were affected by coal ash and they could not think of “a healthy child.”

Emotional, Behavioral, and Learning Disorders

Disorders such as ADHD and autism were highlighted in each focus group. As one woman stated:

Just like in that little section where I live at I found out there's ADHD in this house, skip a house, this house maybe this house, (chuckle) three autistic people that I know of within a half a mile, mile radius within that little bitty section.

Another woman stated: “I have noticed that we all seem to have children that have the ADHD, that has this effect of their learning skills. One of them does has Asperger’s but that’s just another syndrome of Autism.” Other participants highlighted learning difficulties and poor school performance. As one woman voiced: “A lot of children with learning difficulties. There are an extreme large amount of kids out there with learning difficulties...”

Respiratory Disorders

Most focus group participants reported that respiratory conditions such as asthma, breathing problems, and bronchitis were a problem in their neighborhoods. As one woman said: “we all have asthma. It’s just crazy,” and another woman stated: “asthma’s just going rampant.” One mother summarized her personal experience as:

Our littlest one, we adopted her, she was eight weeks old. She’s always lived in the house. She has got all kinds of respiratory issues, I’d say, ever since she was just a few years old. There’s just been increasing allergies, asthma, all kinds of respiratory things. The more she plays outside, the sicker she could get. A lot of times, we’d keep her indoors but she does like to play outside.

Discussion

Coal ash is stored throughout the US with limited monitoring of environmental impact and human health impact. Coal ash has the potential to adversely impact millions of children, yet there is limited research on the risk from exposure. This is the first study to consider the impact of coal ash on communities living near coal ash storage facilities. We used focus groups to highlight the community’s perception of exposure and health among children in neighborhoods adjacent to a coal ash storage facility.

Children are more at risk from the effects of coal ash. Compared with adults, children spend more time outdoors, are more active outdoors, are more likely to breathe through their mouths, breathe more air relative to their lungs and body weight, are physically closer to the ground, are more likely to engage in hand-to-mouth behaviors, and are less likely to stop activity if they experience respiratory distress. Children’s play habits such as crawling, rolling, and digging also put them at risk for greater exposure to pollutants that have settled on the ground or concentrate in the breathing zone. While outside, research has shown that children are three times more active than adults, which significantly increases their oxygen demand and

consequently raises their breathing rates [29–32]. Coal ash storage facilities have the potential to affect more than 1.5 million children in the US and much more research is needed to investigate the health effects associated with coal ash.

The health conditions highlighted in the focus groups represent those that might be associated with exposure to metals or small particles. Exposure to particulate matter is known to cause respiratory disorders [33–36] and exposure to metals has been associated with ADHD [37, 38]. Furthermore, chronic exposure to air pollution and particulate matter has been found to cause chronic inflammation and elevated levels of cytokines in the body and brain increasing the risk for central nervous system (CNS) disease [39, 40]. In experimental models, fine and ultrafine particulate matter is able to pass directly through the nasal olfactory pathway into the circulatory system and brain. It is unclear exactly how the fine particulate matter damages the CNS once circulating in the body [39, 40]. One hypothesis is that the large ratio of surface to volume allows the particles to infiltrate cell membranes, explaining how the particulate matter is able to pass through the lung tissue and the blood–brain barrier. The ability for the fine particulate matter to transverse the blood–brain barrier means that any surface components of the particulate matter also has access into the brain and bloodstream, this is referred to as the Trojan Horse Effect [39]. In regards to coal ash particles specifically, the Trojan Horse Effect could potentially allow high concentrations of heavy metals access to the brain.

The overall themes highlighted in this paper are that although community members liked their neighborhoods, they are trapped by pollution. Community members felt that the health of children in their community is being impacted by pollution that they cannot prevent. There was nothing that could be done to protect children besides moving from the area; even keeping children inside offered little protection. People living near environmental hazards face unique challenges. In this situation, residents face the unique challenge of reducing their exposure to coal ash, both indoors and outdoors. Residents living in the community are exposed daily with no way to realistically reduce exposure. While wearing personal protective equipment like masks and gloves may be useful when cleaning or mowing the lawn, children cannot realistically wear masks when playing outside, nor can you keep children inside all the time. As one participant stated “Our grand kids come to my house. You can’t keep them in the house and they’re going to go outside. Kids love to be outside. They love to ride bikes.” Most parents do take protective measures, but they are reactive, such as washing black feet and making children take baths.

Limitations

There are several limitations of this study which need to be considered. First, the findings from this study might not be generalizable to other communities living near coal ash storage facilities because we recruited participants who lived near one large storage facility in Kentucky. Second, although we invited all members of the community to participate by going door-to-door in the neighborhood and having open community meetings, the participants that took part in the focus group might not be representative of the entire community; they may be affected by coal ash, be more knowledgeable about coal ash, or have children that are suffering from a health condition. The final limitation of the study is that although we focused on coal ash, other air pollution may impact the health and well-being of children in the neighborhoods.

Conclusion

We used focus groups to explore parents' perceptions of their children's exposure to coal ash and health conditions. The potential impact of coal ash on health is great and research investigating coal ash is needed. Research questions focusing on the composition of coal ash from landfills and its effects on the health and well-being of residents living near coal ash storage sites should be made a priority, especially as the EPA looks to make a decision on the proposed coal ash rule.

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