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The Health Impacts of the Shale Revolution

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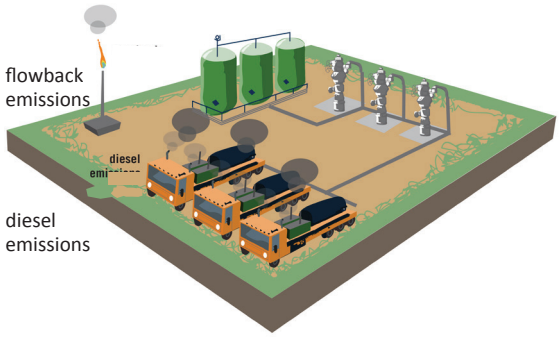
The shale revolution has dramatically increased drilling activity in both densely and sparsely populated regions of the United States. While the industry has operated for decades in major cities such as Los Angeles, the number of communities living alongside oil and gas development has increased in states including Colorado, Pennsylvania, and Texas. This proximity, along with the specific technologies such as hydraulic fracturing used to develop shale plays, has raised concerns over the health risks of living near oil and gas production sites.

Local Risks

Initial concerns over the health impacts of shale development focused on the risks of exposure to proprietary chemical formulas used in hydraulic fracturing. While some of these chemicals can be harmful if encountered in sufficient doses, risks of such exposure for the general public (though not for industry workers) are very small, and there is little to no evidence that substantial health damages have occurred through this pathway.

However, several other pathways of exposure warrant closer attention. First, spills and leaks of produced water, chemicals, or oil at the surface have the potential to damage the environment and pose risks to humans and animals in close proximity. Similarly, well failures known as "blowouts" may occur during the drilling phase, when an oil or gas well is unable to withstand internal pressures, and suffers an uncontrolled release of large quantities of liquids and gases. Although blowouts are very rare, they pose substantial health risks for workers onsite and any nearby residents when they do occur.



A second risk comes from air emissions that occur during the well development, drilling, and completion process. Each of these activities requires powerful diesel engines that often run 24-hours per day for weeks or months at a time. The extent of the health effects from diesel exhaust (which includes volatile organic compounds, particulate matter, and other pollutants) depends on the level and duration of exposure. Immediate health effects include eye, nose, throat, and lung irritation; headaches; nausea; and exacerbation of respiratory and cardiac diseases in sensitive populations.

Along with diesel emissions, air emissions that occur during the flowback stage—after a well has been hydraulically fractured and liquids and gases are flowing back to the surface—pose a potential risk for workers and nearby populations. These emissions include volatile organic compounds and air toxics such as ben-

RFF's Alan Krupnick and Isabel Echarte published *Health Impacts of Unconventional Oil and gas Development* (www.rff.org/oilgashealth), which reviews the health literature. Almost all studies found a positive association between fracking and at least one health outcome (e.g., low birthweight), but the literature overall produces inconsistent results for any given outcome. No study has identified the mechanism for these health impacts, and only one study reviewed was able to assess each link in the causal chain below. Overall, more research is needed to assess and characterize health impacts.

* This is one of a series issue briefs based on *The Fracking Debate: The Risks, Benefits, and Uncertainties of the Shale Revolution* (Columbia University Press, 2017) by Daniel Raimi. Raimi is a senior research associate at Resources for the Future.

zene and hydrogen sulfide, each of which have serious health consequences when encountered in sufficient quantities.

Perhaps the most well-documented health risks of shale development stem from vehicle accidents associated with the thousands of heavy truck trips required to develop each new well. Numerous studies and strong anecdotal evidence show a substantial increase in injuries and fatalities due to these accidents.

Regional and National Benefits

Along with the health risks described above, the shale revolution has brought about major health benefits through the displacement of coal-fired electricity by low-cost natural gas. Air emissions of sulfur dioxide, nitrogen oxides, mercury, and other pollutants from coal-fired power plants contribute to thousands of premature deaths each year in the United States. Numerous studies have determined that low cost natural gas from the shale revolution has been the leading contributor to reductions in coal-fired power, substantially reducing the level of these emissions.

The health benefits of coal to gas switching in the power sector are widely dispersed, unlike the health risks of shale development, which are concentrated near well sites. The greatest health benefits from reducing coal-fired power accrue broadly to the upper Midwest, the Southeast, and other regions that are "downwind" from large plants.

Research Findings and Remaining Uncertainty

In recent years, dozens of studies have been published examining the potential health impacts of shale development. However, a variety of factors has made it extremely difficult for researchers to directly observe health effects. Ideally, studies would measure each link in the causal chain that could potentially lead to health impacts from oil and gas development, as illustrated in the figure below.

Instead, most studies measure a subset of these links, such as activities (the amount of oil and gas activity in a specific area) and impacts (health measures for individuals living near those activities). Without measuring the other links in the causal chain such as burdens, concentrations, and exposure, it is difficult to have certainty in study results.

Despite these methodological challenges, numerous studies present cause for additional research, and a smaller number provide fairly compelling evidence of health risks. These higher quality studies have found evidence of increased prevalence of low birth weight and other negative health outcomes for babies born to mothers who carry their children in utero within 1 kilometer of well sites. The negative effects found by these studies are not drastic—for example, birthweights on average decrease by a small percentage—but they are fairly compelling due to the high quality of the methodologies taken by the researchers.

Implications for Policy

Despite the real concerns over health risks of living near shale development, researchers have not identified the pathway such as air emissions, water contamination, psychological stress, or any other cause—through which an individual's health may be affected. This means that the policy implications of research findings are unclear. However, it is clear that additional and higher quality research is needed to accurately identify the risks, which will provide a more solid foundation for policymakers dedicated to protecting public health.

In the absence of definitive research, numerous state governments have mandated (and some operators have voluntarily implemented) "green completion" technologies, which substantially limit the air emissions during flowback, reducing the potential for negative health outcomes. An additional policy measure that would likely reduce risk would involve enhancing setback requirements, though the ideal setback distance remains uncertain.