The Science Behind the Need for Health Buffers from Oil and Gas

Summary of Key Articles and Reports
Silas Grant, PhD, Center for Biological Diversity
For more information, contact
Gail Evans (gevans@biologicaldiversity.org) or Colin Cox (ccox@biologicaldiversity.org)

There is abundant research that describes and provides evidence for the health risks and harms of oil and gas production and pollution (see, for example, the 9th edition of the fracking compendium). With the aim of informing policy to reduce public health hazards, this summary highlights research that addresses the question of *distances* at which increased health risks and harms from oil and gas activities are observed to occur.

Approximately 144,000 New Mexicans reside within a half-mile (2,640 feet) of oil and gas production. About half of these people are people of color.[1] Over 34,000 children go to school within a mile of oil and gas facilities.

There is ample scientific evidence to support a minimum setback distance of at least a 1 mile (5,280 feet) to mitigate harms to public health, especially for vulnerable populations, including children and pregnant people.

For example, the following studies, summarized below, all find evidence of harm at distances of a mile (5,280 feet) or greater:

- Gaughan et al. (2023) found that individuals residing within **10 km** of unconventional oil and gas development during pregnancy were at higher risk of having a child with birth defects.
- Talbott et al. (2023) found that children who live within **1 mile (5,280 feet)** of an unconventional gas well are 5-7 times more likely to develop lymphoma than unexposed children. Children living within **2-5 miles** of unconventional gas wells are 2 times more likely to develop lymphoma than unexposed children.
- Buchanich et al. (2023) found that there is an increased risk of asthma exacerbations during unconventional gas production at exposure zones of **1 mile, 2 miles, 5 miles, and 10 miles.**
- Buchanich and Talbott (2023) found that there is an increased risk for low birth weights and small gestational age births when individuals reside within **2**, **5, and 10 miles** of unconventional natural gas production.
- Gonzales et al. (2022) found higher concentrations of ambient air pollutants within **4 km (13,123 feet)** of preproduction wells and within **2 km (6,561 feet)** of producing wells.

[1] Earthworks & FrackTracker, The Oil & Gas Threat Map (2023), https://oilandgasthreatmap.com/threat-map/newmexico/

- Cairncross et al. (2022) found that individuals who resided within **10 km (32,808 feet)** of one or more fracking wells during pregnancy were at higher risk for adverse birth outcomes.
- Apergis et al. (2019) found that that there is an increased risk of adverse health outcomes for infants when individuals reside at distances of up to **20 km**, with greater harms within 1 km.
- Currie et al. (2018) found a 25% increased risk of low birthweight, a significant decline in average birthweight, and decreased overall health index for infants born to individuals living within 1 km of an active well site that was fracked, and elevated risks for infants born to mothers living at up to **3 km** from active well sites.

Additionally, Rabinowitz et al. (2015) found that persons living within **1 km** of natural gas wells were more likely to experience respiratory and skin problems than persons living 2 km or more from natural gas wells in Pennsylvania. Shamasunder et al. (2018) found that there is a significantly higher risk of asthma for people living within 1,500 feet of oil and gas. And, Tran et al. (2021) found that proximity to hydraulic fracturing within **1 km (3,280 feet)** during pregnancy was associated with adverse birth outcomes.

In a comprehensive review of existing literature, Shonkoff et al (2021) found that "existing epidemiologic studies were not designed to test and establish a specific "safe" buffer distance between OGD [oil and gas development] sites and sensitive receptors, such as homes and schools. Nevertheless, studies consistently demonstrate evidence of harm at distances less than 1 km, and some studies also show evidence of harm linked to OGD activity at distances greater than 1 km (12)." Shonkoff et al. (2021) present a hierarchy of protective strategies to reduce human health hazards from oil and gas pollution. **The most protective strategy is to eliminate oil and gas development. The next most protective strategy is to introduce setbacks for new and existing wells combined with engineering controls.**

Study Summaries

COMPREHENSIVE LITERATURE REVIEW AND PANEL ANALYSIS

Report from California Scientific Advisory Panel
Shonkoff, Seth B.C. et al., *Response to CalGEM Questions for the California Oil and Gas Public Health Rulemaking Scientific Advisory Panel* (October 1, 2021),https://www.conservation.ca.gov/calgem/Documents/public-health/Public%20Health%20Panel%20Responses_FINAL%20ADA.pdf.

About: The California Oil and Gas Public Health Rulemaking Scientific Advisory Panel, a group of experts appointed by the California Department of Conservation, answers the written questions sent by the California Geologic Energy Management Division (CalGEM) on August 31, 2021. The panel conducted a comprehensive review of existing literature to answer these questions.

Key findings:

- Health harms: The panel concludes with a high level of certainty that the epidemiologic evidence indicates that close residential and geographic proximity to oil and gas development is associated with adverse perinatal and respiratory outcomes (p.1).
    - The panel finds with a high level of certainty that exposure to oil and gas development causes significant increased risk of poor birth outcomes (p.3).
    - The panel concludes with a high level of certainty that there is a *causal relationship* between close geographic proximity to and adverse perinatal and respiratory outcomes (p.4).
- Types of Oil and Gas Development: The panel concludes with a high level of certainty that human health studies focused on unconventional *and* conventional oil and gas development are relevant to consider in the California context where conventional development is most prevalent. In other words, while unconventional development (hydraulic fracturing) poses some specific health risks, the majority of health risks and stressors are similar across conventional and unconventional development, and the same studies can be considered.
- Sources: Harmful air emissions are released during different oil and gas activities. Wells, valves, tanks and other equipment used to produce, store, process and transport petroleum products are associated with emissions of toxic air contaminants, hazardous air pollutants and other health-damaging non-VOCs (p.10). Diesel engines used to power on-site equipment and trucks and oil and gas development sites directly emit health damaging hazardous air pollutants, fine particulate matter, and nitrogen oxides and VOCs (p.10).
- Setback Distance: "The Panel concludes with a high level of certainty that concentrations of health-damaging air pollutants, including criteria air pollutants and toxic air contaminants, are more concentrated near OGD activities compared to further away" (p. 11).
    - "Existing epidemiologic studies were not designed to test and establish a specific "safe" buffer distance between OGD [oil and gas development] sites and sensitive receptors, such as homes and schools. Nevertheless, studies consistently demonstrate evidence of harm at distances less than 1 km, and some studies also show evidence of harm linked to OGD activity at distances greater than 1 km." (p.12)
    - A "hierarchy of strategies" to reduce human health hazards. The most protective action is to reduce or eliminate new and existing oil and gas wells. The next most protective actions are setbacks for existing and new wells, combined with engineering controls. Further measures (less protective) are also outlined (p.12).
    - Neither setbacks nor engineering controls alone are sufficient to reduce health hazards and risks from oil and gas – both are needed in tandem (p.13).
- Benefits of setbacks: There are significant potential health benefits to be gained by reducing air and noise pollution from oil and gas (p.15).

HEALTH HARMS – VARIOUS AGES

Skin and Respiratory Symptoms, 1 km
Rabinowitz, Peter M. et al., *Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania*, 123 Environmental Health Perspectives 21 (2015), https://ehp.niehs.nih.gov/doi/pdf/10.1289/ehp.1307732

About: This study investigated the relationship between household proximity to natural gas wells and reported health symptoms. The authors conducted community environmental health assessment of 492 persons (180 households) in Washington County, Pennsylvania, where there is active gas drilling within 1 km.

Key findings:

- The number of health symptoms per person was higher among residents living within 1 km or less from the nearest gas well compared to residents living 2 km or more from the nearest gas well.
- Skin conditions and upper respiratory problems were more frequently reported in people living in homes within 1km or less to the nearest gas well, compared to people living within 2 km or more from the nearest gas well.
- Three possible causes for the prevalence of skin and other problems among residents living within 1 km or less from gas wells: contamination of well water from gas production (all people surveyed had ground-fed water supply), air pollution from gas pollution, and anxiety due to knowledge of environmental risks from gas production.

Childhood Lymphoma, 0-5 miles
Talbott, Evalyn et al., *Final Report for Pennsylvania Department of Health, Bureau of Epidemiology, Hydraulic Fracturing Epidemiology Research Studies: Childhood Cancer Case-Control Study*, (August 3, 2023), https://www.health.pa.gov/topics/Documents/Environmental%20Health/Report_Cancer_outcomes_2023.pdf

About: A case-control study of childhood cancers initiated by the Pennsylvania Governor Wolf's administration due to concerns about the Ewing sarcoma cluster and significant rise of hydraulic fracturing and unconventional gas development (UNGD) in western Pennsylvania since 2005. Considered four phases of UNGD (well pad prep, drilling, hydraulic fracturing, and production). Considered exposure distances by buffer zones of 0-0.5 miles, 0.5-1 mile, 1-2 miles, and 2-5 miles.

Key findings:

- Lymphoma: This study provided moderate evidence suggesting an association between unconventional gas development (UNGD) and childhood lymphoma.
    - Children who live within 1 mile of a well are 5-7 times more likely to develop lymphoma than unexposed children (who live 5 miles or farther away from oil and gas).

    - Children who live between 1-2 miles from a well are 2.45 times more likely to develop lymphoma than unexposed children.
    - Children who live between 2-5 miles from UNGD are 2 times more likely to develop lymphoma than unexposed children.
- Bottom line: The closer a child lives to a UNGD site, the higher the risk of lymphoma.

Asthma Exacerbations, 0-10 miles

Buchanich, Janine. et al., *Final Report for Pennsylvania Department of Health, Bureau of Epidemiology, Hydraulic Fracturing Epidemiology Research Studies: Asthma Outcomes*, (July 31, 2023), https://www.health.pa.gov/topics/Documents/Environmental%20Health/Report_Asthma_outcomes_2023.pdf

About: A retrospective study cohort study of asthma (46,676 patients) to deepen understanding of relation between asthma and exposure to unconventional natural gas development (UNGD) in Southwestern Pennsylvania, where UNGD has proliferated. Considered exposure zones of 10 miles, and buffer distances of 1 mile, 2 miles, 5 miles, and 10 miles. Considered four phases of UNGD (well pad prep, drilling, hydraulic fracturing, and production). Considered three types of asthma events: severe, ED severe, and hospitalization severe.

Key findings:

- Strong evidence to suggest an increased risk in the production phase of unconventional natural gas development for all buffer zones (1, 2, 5, and 10 miles) for all types of asthma events (severe, ED severe, and hospitalization).
- Bottom line: Proximity to UNGD increases risk to asthma exacerbations.

Higher Rates of Asthma, 1,500 feet

Shamasunder, Bhavna. et al, *Community-Based Health and Exposure Study around Urban Oil Developments in South Los Angeles*. Int J Environ Res Public Health, 15(1) (January 15, 2018), 138. doi: 10.3390/ijerph15010138.

About: Community-based health and exposure survey in South Los Angeles. Researchers tested the capacity of low-cost sensors to measure localized exposures, and surveyed residents within two 1,500 buffer areas (from oil and gas) and compared overall test rates to the California Interview Survey for Services Planning Area 6 (SPA6) and Los Angeles County.

Key Findings:

- The age-adjusted rate of diagnosed asthma was significantly higher in both surveyed neighborhoods than in the SPA6.
- Residents in these buffer areas experienced asthma symptoms of coughing and wheezing on a weekly or daily basis

ADVERSE BIRTH OUTCOMES

Adverse Birth Outcomes, 10 km

Cairncross ZF, et al., *Association Between Residential Proximity to Hydraulic Fracturing Sites and Adverse Birth Outcomes*, JAMA Pediatr. Jun 1;176(6):585 (2022), https://pubmed.ncbi.nlm.nih.gov/35377398/

About: A study of 26,193 people with 34,873 unique pregnancies in Alberta, Canada. Individuals were considered exposed if they lived within 10 km of 1 or more fracked (hydraulically fractured) well during year 1 of preconception or during pregnancy.

Key findings:

- Small for gestational age and major congenital anomalies were significantly higher for individuals who lived within 10 km of at least 1 fracked well.
- Risk of spontaneous preterm birth and small for gestational age were significantly increased in those with 100 or more wells within 10 km.
- Bottom line: Individuals who are exposed to fracking during pregnancy may be at higher risk of several adverse birth outcomes.

Birth Defects, 10 km

Gaughan, Casey. et al., *Residential Proximity to Unconventional Oil and Gas Development and Birth Defects in Ohio*, Environ Res, (2023), https://pubmed.ncbi.nlm.nih.gov/37076028/

About: A registry-based cohort study of nearly one million live births in Ohio between 2010-2017, where gas production increased significantly during that time period. Exposure to fracking was assigned based on maternal residential proximity to unconventional oil and gas wells (within 10 km) and based on whether residences were hydrologically connected to oil and gas wells.

Key findings:

- Bottom line: There is a higher level of birth defects for children born to mothers living within 10 km of unconventional oil and gas development as compared to unexposed mothers.
- Birth defects: neural tube defects, limb reduction defects, and spina bifida.

Low Birthweights and Small for Gestational Age, 10 miles

Buchanich, Janine and Talbott, Evalyn, *Final Report for Pennsylvania Department of Health, Bureau of Epidemiology, Hydraulic Fracturing Epidemiology Research Studies: Birth Outcomes*, (July 31, 2023), https://www.health.pa.gov/topics/Documents/Environmental%20Health/Report_Birth_outcomes_2023.pdf

About: A retrospective cohort study of birth outcomes in Southwestern Pennsylvania where unconventional natural gas production has surged. Looked at live births between 2010-2020.

Assessed four birth outcomes: 1) low 5-minute apgar score, small for gestational age, preterm birth, and term birthweight. Considered five buffer distances: 0.5 miles, 1 mile, 2 miles, 5 miles, and 10 miles of exposure to unconventional gas activity, also accounting for cumulative well count. Considered four phases of development: well pad preparation, drilling, hydraulic fracturing, and production.

Key findings:

- Small for gestational age: Moderate to strong data to suggest an increased risk for small to gestational age births at exposure within 2-, 5-, and 10-mile residential buffers.
- Term birthweight (birthweight in grams between 37-41 weeks gestation): statistically significant association between residential proximity to unconventional natural gas production and low birthweight within 5- and 10-mile buffers. Statistically significant reductions in birthweight with increasing intensity of exposure (p.58-59).
    - "There were moderate data to support that reductions in term birthweight were associated with proximity to both compressor stations and facilities accepting oil and gas waste" (61) – Indicating that additional studies should investigate non-well oil and gas production activities and infrastructures.
- Preterm births: Found moderate association between preterm births and exposure to PM2.5 (particulate matter) as has been shown previously in multiple studies in the United States and internationally.

Adverse Infant Health Outcomes, 1-3 km

Currie, Janet, et al., *Hydraulic Fracturing and Infant Health: New Evidence from Pennsylvania*, Scence Advances, 3(12), (Dec 13, 2017), 10.1126/sciadv.1603021

About: An analysis of more than 1.1 million births in Pennsylvania between 2004-2013, comparing infants born to mothers at different distances from active fracking sites and those born before and after fracking started. Considered births within 0-1 km of fracking, 1-2 km of fracking, and 2-3 km, and compared data within these zones to the unaffected group (mothers 3-15 km)

Key Findings:

- "Maternal residence within 1 km [3,280 feet] of an active well site that was hydraulically fractured before conception is associated with significantly worse infant health outcomes than are more distant locations."
- Health harms to infants occur at up to 3 km (9.842 feet), with the greatest risk to infants born to mothers living within 1 km of an active oil and gas site during pregnancy. For those infants/mothers, a 25% increase in probability of low birthweight was observed, and a significant decline in average birthweight and in index of infant health.

Infant Mortality, 1 km-10 km
Apergis, Nicholas, Hayat, Tasawar. & Saeed, Tareq, *Fracking and Infant Mortality: Fresh Evidence from Oklahoma*, Environ Sci Pollut Res 26, 32360–32367 (2019). https://doi.org/10.1007/s11356-019-06478-z

About: Analyzed relationship between birth health and proximity to fracking wells within buffer zones of 1 km, 5 km, 10 km, and 20 km from mother's residence in Oklahoma.

Key Findings:

- Proximity to fracking wells during pregnancy causes negative health impacts for infants. The study found negative impacts to infant total health index at distances of up to 20 km, with the strongest impacts occuring within the 1 km distance.
- Risks of infant mortality were observed at 5 km – 10 km distance
- Risks of low birthweight are significant within 10 km, and strongest within 1 km.

Adverse Birth Outcomes, 1 km
Tran, Kathy V. et al., *Residential Proximity to Hydraulically Fractured Oil and Gas Wells and Adverse Birth Outcomes in Urban and Rural Communities in California (2006-2015)*, 5 Environmental Epidemiology e172 (2021), https://pubmed.ncbi.nlm.nih.gov/34909552/

About: A retrospective cohort study of nearly one million births in eight California counties with hydraulic fracturing between 2006-2015 with at least 1 well hydraulicly fractured within 1 km of their home during pregnancy. Examined association between fracking and low birth weight, preterm birth, small for gestational age birth, and term birth weight.

Key findings:

- Among rural mothers living within 1 km of fracking during pregnancy, exposure to fracking was associated with increased odds of low birth weight, small for gestational age birth, preterm birth, and lower term birth weight. Among urban mothers living within 1 km of fracking during pregnancy, exposure to fracking was positively associated with small for gestational age birth.
- Bottom line: Proximity to fracking during pregnancy was associated with adverse birth outcomes, particularly in rural areas.

AMBIENT AIR POLLUTION FROM OIL AND GAS

Upstream Oil and Gas Production and Ambient Air Pollution in California
Gonzalez, David al., *Upstream Oil and Gas Production and Ambient Air Pollution in California*, Science of The Total Environment. Volume 806, Part 1, (2022), https://www.sciencedirect.com/science/article/pii/S0048969721053754

About: This study investigated whether drilling new wells (pre-production) or increasing production at existing wells increased concentrations of particulate matter, carbon monoxide, nitrogen oxide, ozone, and VOCs. The study is in California.

Key Findings:

- Preproduction/Drilling: Observed higher concentrations of PM2.5 (particulate matter) and CO (carbon monoxide) at preproduction wells. Observed higher concentrations of NO2 (nitrogen oxide) at monitors at 1-2km from wells and O3 (ozone) from 2-4km from the wells.
- Increased production: Monitors near wells that were increasing their production observed higher concentrations of PM2.5, NO2, and VOCs within 1km, and higher O3 concentrations at 1-2km.
- Bottom line: Observed higher concentrations of ambient air pollutants within 4km (13,123 feet) of preproduction wells (drilling) and within 2km (6,561 feet) of producing wells.