Oil and Gas Development: Evaluating the Health Implications

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The Upstream Extraction of oil and natural gas is an Industrial Process
Potential Environmental Stressors  (Witter et al 2013)

- Air quality
- Water quality
- Traffic
- Noise, Light, and Vibrations
- Economic conditions
- Social conditions
- Health infrastructure
- Accidents/malfunction
Concentrations of hazardous air pollutants increase with density of oil and gas wells

Halliday et al. 2016

Figure 1. Map of the 2014 DISCOVER-AQ study area. The urban areas are shown in grey (data courtesy of the United States Census Bureau, http://www.census.gov/geo/maps-data/data/tiger.html). The boundary of the WGF is shown in black along with the gas wells (brown points) (data courtesy of the Colorado Oil and Gas Conservation Commission, http://cogcc.state.co.us/). The DISCOVER-AQ ground sites are plotted and colored using the mean benzene volume mixing ratio measured during the aircraft spirals over each site. Benzene statistics were calculated using data from the bottom 1 km agl for each site.
Repeated peak exposure potentials at night, before sunrise
Noise at 1000 feet with sound wall:

- Highest measurement (A-Weighted)
- Lowest measurement (A-Weighted)
Between 2006 and 2015, 116 fires and explosions in Colorado: Average of 31 homes within 1 mile  
Blair et al. 2017

Firestone, Colorado, CBS:  
http://denver.cbslocal.com/2017/05/25/anadarko-to-shut-down-3-wells-near-house-explosion-site/

Mead, Colorado, Mountain View Fire Rescue
Public Health Studies: Level of Evidence

- **Predictive**
- **Epidemiological Studies/Population-Based**

**Descriptive – Hypothesis Generating**

- **HIA**
  - Exposures Potential
  - Health Effects
  - Recommendations

- **Risk Assessment**
  - Estimate exposures and health risk

- **Case Series**
  - Document Health Outcomes

- **Ecological Studies**
  - Health outcomes and exposures at the group level

Increasing Level of Evidence
Conclusions

- People living nearest to the well pads may be at increased risk for neurologic, developmental, endocrine system, and respiratory health effects, as well as cancer and stress. (Colburn et al. 2012, Ellison et al. 2016, McKenzie et al 2012, Steinzor et al. 2013, Ferrar, Human cell lines exposed to water samples from O&G areas (Kassotis 2014)
- Risk for exposures and health effects is greatest during periods of short-term, high air emissions that may occur during specific events or with specific equipment (McKenzie et al. 2012; Allen et al. 2013) and may be higher at night (Halliday et al. 2016).
- Cases of bladder, thyroid, and childhood central nervous system, cancers higher than expected in Pennsylvania counties with hydraulic fracturing (Frysek 2013; Finkel 2016)
- Cardiology and neurology hospitalizations increase with increasing density of wells in zip code (Jemielita 2015).
- Pregnant woman living near O&G development in Canada have higher levels of one out of two markers of benzene in their urine (Caron-Beaudoin et. al. 2018)
Limitations of Ecologic studies

Colorado School of Public Health
Analytic: The Proximity Studies

Predictive

Epidemiological Studies/Population-Based

Descriptive – Hypothesis Generating

HIA
Exposures Potential Health Effects
Recommendations

Risk Assessment
Estimate exposures and health risk

Case Series
Document Health Outcomes

Ecological Studies
Health outcomes and exposures at the group level

Case-Control Studies
Identify individuals with and without health outcome and compare exposures

Cohort Studies
Follow exposed and unexposed individuals and compare health outcomes

Increasing Level of Evidence
Location of the wells in relation to the home matters
Measure the distance of each O&B well from the home.
Inverse Distance Weighting (IDW)

\[
\text{inverse distance} = \frac{1}{\text{distance of well from mother's home}}
\]
Sum the inverse distances

- All wells 1 mile away: $\text{IDW} = \frac{1}{1} + \frac{1}{1} + \frac{1}{1} + \frac{1}{1} = 4$

- All wells 5 miles away: $\text{IDW} = \frac{1}{5} + \frac{1}{5} + \frac{1}{5} + \frac{1}{5} = 0.8$

- 2 wells 1 mile away, 2 wells 2 miles away: $\text{IDW} = \frac{1}{1} + \frac{1}{1} + \frac{1}{2} + \frac{1}{2} = 2.4$
Maternal proximity to oil and gas development and birth outcomes

124,832 infants born between 1996 and 2009 in rural Colorado

- Rural areas and towns with populations less than 50,000 (Denver-Metropolitan area, El Paso County and the cities of Fort Collins, Boulder, Pueblo, Grand Junction and Greely excluded)
- White Hispanic and Non-Hispanic Mothers
- Singleton live births
More infants with congenital heart defects for mothers in high density oil and gas areas

Low = first tertile, 1 to 3.62 wells per mile, medium = second tertile, 3.63 to 125 wells per mile, high = third tertile, 126 to 1400 wells per mile. Adjusted for maternal age, ethnicity, smoking, alcohol use, education, and elevation of residence, as well as infant parity and gender.

McKenzie et al 2014
Proximity to oil and natural gas wells and childhood acute lymphocytic leukemia and non-Hodgkin lymphoma

- Registry-based case-control study
- 743 children from the Colorado Central Cancer Registry
  - Residing in rural Colorado
  - Diagnosed between 2001 and 2013
  - Age 0-24 years at time of diagnosis
  - Geo-coded address to rooftop accuracy
- 87 ALL Cases
- 50 NHL Cases
- 528 control: children with non-hematologic cancers
  - 78 children with another type of leukemia or Hodgkin lymphoma excluded
More children with acute lymphocytic leukemia live in areas of high density oil and gas wells. McENRIE et al 2017

low = first tertile, < 4.9 wells per mile, medium = second tertile, 4.9 to 33.6 wells per mile, high = third tertile, more than 33.6 wells per mile. Adjusted for age, race, gender, SES, and elevation. McENRIE et al 2017
Conclusions from health-proximity studies in other states

Health conditions more likely as proximity to UNGD wells/activity increases:

• Low birth weight  (Stacy et. al. 2015, Currie et. al. 2017)
• Preterm birth and high risk pregnancy  (Casey et. al. 2015, Whitworth et. al. 2017)
• Asthma exacerbations  (Rasmussen et. al. 2016)
• Nasal and sinus, migraine headache, and fatigue symptoms  (Tustin et. al. 2016)
• Fetal Death  (Whitworth et. al. 2017)
What the health studies do not tell us

- Actual exposures:
  - What are people exposed to – if anything - and at what concentration/level?
  - Is O&G development the source of the exposures or is it something else?
  - If it is O&G, what activities are the source of the exposure?
  - Chemical stressors or non-chemical stressor?
  - Social stressors?
- The distance O&G development should be to minimize potential for health effects
Current Studies at the Colorado School of Public Health

- Follow-on study for congenital heart defects (American Heart Association)
- Cumulative risk assessment considering chemicals in air and water, noise, traffic, and accidents (National Science Foundation)
- Quality of life and subclinical biomarkers: comparing Greeley and Fort Collins Populations (National Institute of Environmental Health Sciences)
Bibliography

- Rasmussen, S. G.; Ogburn, E. L.; McCormack, M.; et al., ASSociation between unconventional natural gas development in the marcellus shale and asthma exacerbations. JAMA Internal Medicine 2016
- Whitworth, K.W., Marshall, A.K., Symanskiet, E. Maternal residential proximity to unconventional gas development and perinatal outcomes among a diverse urban population in Texas.