Unconventional Natural Gas Development and Public Health: What Do We Know?

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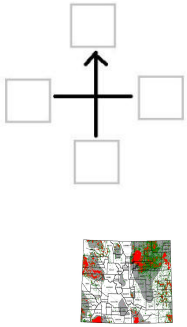
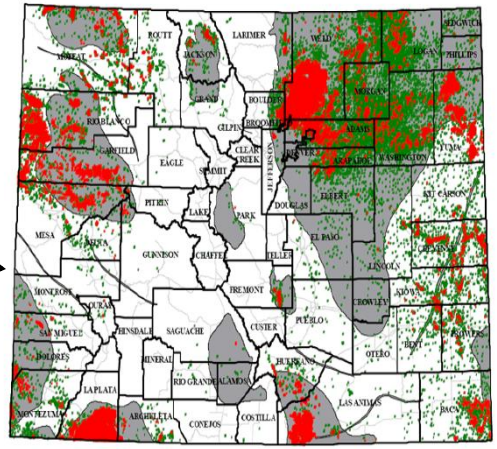
Roadmap

- **Unconventional O&G Development**
  - Background and potential health impacts
- **Public Health Questions:**
  - Populations: Who's exposed, are they vulnerable, and how risky is the process?
  - What health effects/concerns have been associated with extraction?
  - What approaches can be used to minimize population health impacts?
  - What are the key knowledge gaps?

Canada





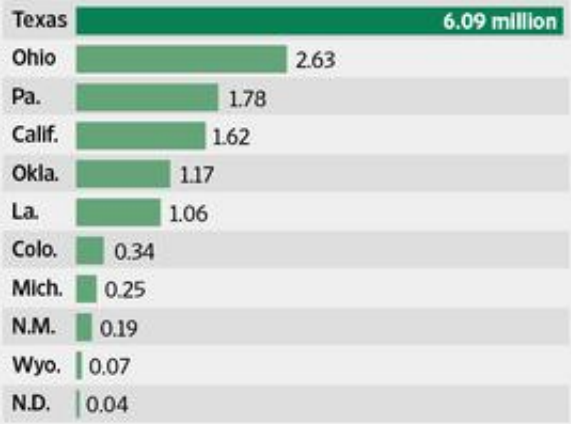
Context: The Unconventional O&G Boom in the US

- Wall Street Journal, October 25, 2013
  - "More than 15 million Americans live within a mile of a well that has been drilled and fracked since 2000."

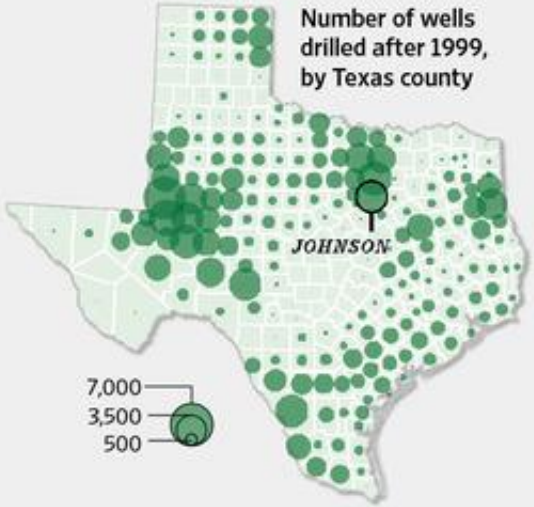
Neighborhood Wells

A Wall Street Journal analysis looked at oil- and gas-well locations and population data in 11 major energy-producing states. Some of the findings:

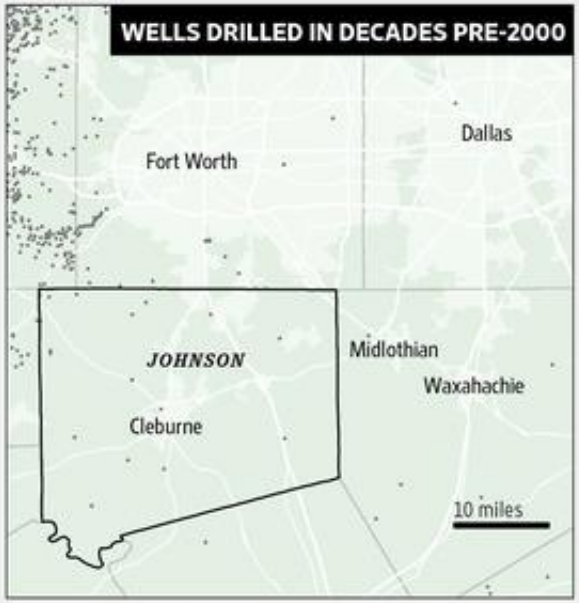
Population in census blocks within one mile of a well drilled after 1999

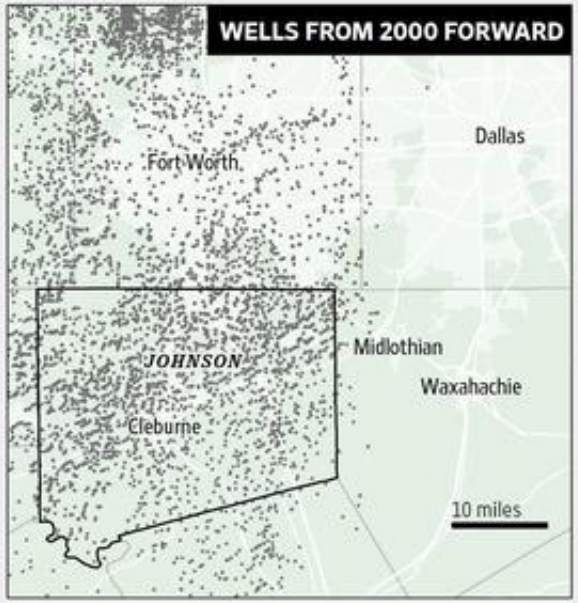


Number of wells drilled after 1999, by Texas county



Johnson County, Texas, near Fort Worth, saw one of the largest drilling booms in the nation. Prior to 2000, there were only a handful of wells in the county. Now there are more than 3,900.





Sources: DrillingInfo; Census Bureau; Ohio Dept. of Natural Resources

Analysis by Tom McGinty, graphic by Renée Rigdon/The Wall Street Journal

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Critical Review

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Potential Public Health Hazards, Exposures and Health Effects from Unconventional Natural Gas Development

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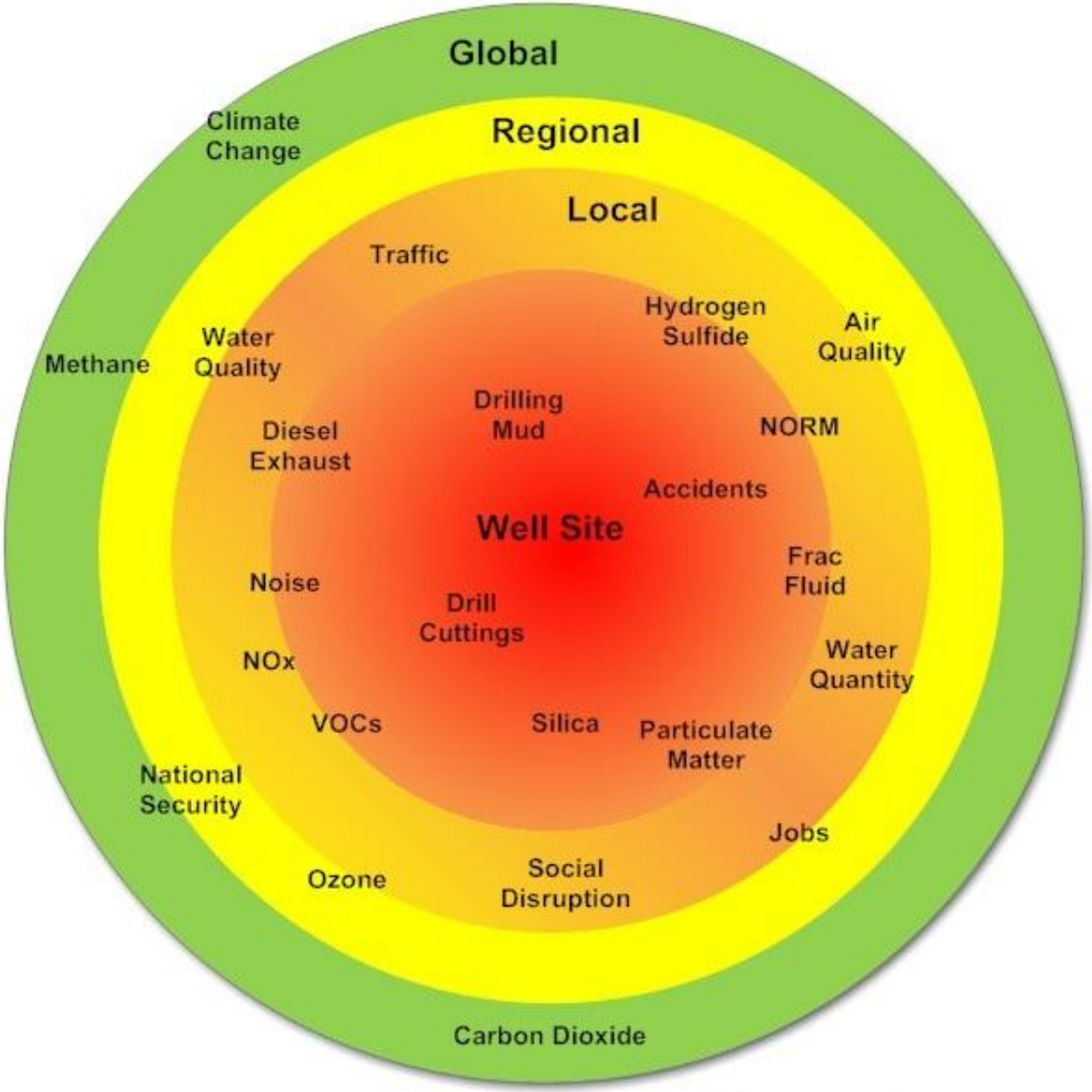
ABSTRACT: The rapid increase in unconventional natural gas (UNG) development in the United States during the past decade has brought wells and related infrastructure closer to population centers. This review evaluates risks to public health from chemical and nonchemical stressors associated with UNG, describes likely exposure pathways and potential health effects, and identifies major uncertainties to address with future research. The most important occupational stressors include mortality, exposure to hazardous materials and increased risk of industrial accidents. For communities near development and production sites the major stressors are air pollutants, ground and surface water contamination, truck traffic and noise pollution, accidents and malfunctions, and psychosocial stress associated with community change. Despite broad public concern, no comprehensive population-based studies of the public health effects of UNG operations exist. Major uncertainties are the unknown frequency and duration of human exposure, future extent of development, potential emission control and mitigation strategies, and a paucity of baseline data to enable substantive before and after comparisons for affected populations and environmental media. Overall, the current literature suggests that research needs to address these uncertainties before we can reasonably quantify the likelihood of occurrence or magnitude of adverse health effects associated with UNG production in workers and communities.


Global
Climate Change
Regional
Local
Traffic
Hydrogen Sulfide
Air Quality
Methane
Water Quality
Drilling Mud
Diesel Exhaust
NORM
Accidents
Well Site
Frac Fluid
Noise
Drill Cuttings
Water Quantity
NOx
VOCs
Silica
Particulate Matter
National Security
Jobs
Ozone
Social Disruption
Carbon Dioxide

Population Health: What is Public Health in This Context?

- **Optimize the health of populations over time**
  - Workers and Communities
  - Highly dependent on activities, hazards and exposure mitigations
- Not just about standards for what is “safe”
  - **Technology-based standards** and **Health-based standards** are context dependent
  - Links to **Best Management Practices** and Process Improvements need to be explicit and have teeth

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- Air quality management
- Air emissions study

Battlement Mesa HIA/EHMS

Battlement Mesa Health Impact Assessment (2nd draft)

The Battlement Mesa Health Impact Assessment (HIA) is a document that provides objective information and evidence-based recommendations to increase the potential health benefits of natural gas drilling in the Battlement Mesa PUD, while minimizing potential health risks. On March 1, 2011, the second draft of the HIA became available for stakeholders in the community to review. We invited community stakeholders, including stakeholders in government, citizen groups, academia and the private sector, to submit questions, criticisms and comments that they may have about the HIA.

resources

New! EHMS Final Design December 2011

Health Impact Assessment 2nd draft

http://www.garfield-county.com/environmental-health/battlement-mesa-health-impact-assessment-ehms.aspx

AJPH June 2013

The Use of Health Impact Assessment for a Community Undergoing Natural Gas Development

Roxana Z. Witter, MD, MSPH, Lisa McKenzie, PhD, MPH, Kaylan E. Stinson, MSPH, Kenneth Scott, MPH, Lee S. Newman, MD, MA, and John Adgate, PhD, MSPH

The development of natural gas wells is rapidly increasing, yet little is known about associated exposures and potential public health consequences. We used health impact assessment (HIA) to provide decision-makers with information to promote public health at a time of rapid decision making for natural gas development. We have reported that natural gas development may expose local residents to air and water contamination, industrial noise and traffic, and community changes. We have provided more than 90 recommendations for preventing or decreasing health impacts associated with these exposures. We also have reflected on the lessons learned from conducting an HIA in a politically charged environment. Finally, we have demonstrated that despite the challenges, HIA can successfully enhance public health policymaking. (*Am J Public Health*. Published online ahead of print April 18, 2013: e1–e9. doi:10.2105/AJPH.2012.301017)

Many regions of the United States hold large natural gas reserves.[1] Colorado is one of the states experiencing rapid natural gas development. Applications for permits to drill rose from 1939 in 2003 to 7870 in 2008[2,3] and natural natural gas wells in the community, some of which would be approximately 500 feet from homes. The well development phase would be 5 years, followed by a 20- to 30-year production phase.

"complete physical, mental, and social well-being"[17] and understanding that living environment is a determinant of health,[18] we addressed a wide range of potential exposures from natural gas development and the subsequent effects these exposures could have on public health. Because we conducted the HIA before the project had begun, site-specific data for exposures were not available; instead we used exposure data from other local sites where natural gas development had occurred and medical literature to describe the known health effects of such exposures. Throughout the HIA process, we worked closely with county public health professionals and received technical guidance and support from experienced HIA practitioners. The full HIA and supporting documents are available on the county Web site.[19]

Potential Adverse Effects

CHEMICAL

- Acute (e.g., respiratory tract irritation)
- Chronic (e.g., asthma exacerbation)
- Cancer risk

INDUSTRIAL ACTIVITIES

- Traffic and other accidents
- Noise, light, vibration
- Catastrophic risks

COMMUNITY CHANGES

- Changes in Place Attachment
- Decreased physical activity
- School enrollment turnover
- Decreased social engagement
- Psychosocial stress

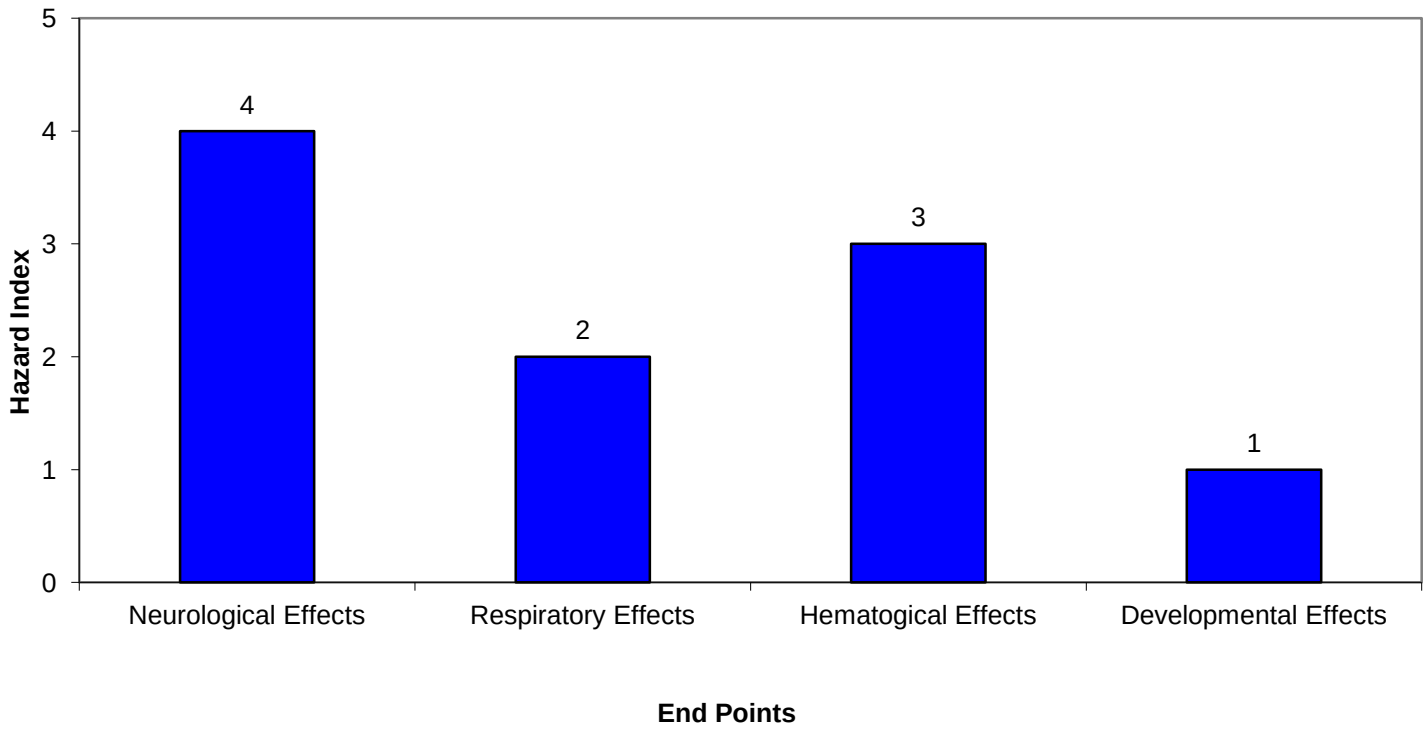
Air Quality During Well Completion

- Mckenzie et al, 2012.
  - Human Health Risk Assessment
  - Limited number of “flowback” samples as well as area samples
  - Risk of sub-chronic and chronic non- cancer health effects and lifetime excess cancer risk

Human Health Risk Assessment

- "Screening" Risk Estimates Using EPA methods
  - EPA Reference Concentrations (RfCs), inhalation unit risks, and other health-based guidelines when RfCs or cancer potency estimates not available
  - Scenario-based chronic and subchronic assessments for nearby residents
- Quantitative Risk Assessment
  - Non Cancer (Systemic): Hazard Index
    - *Ratio of estimated exposure to RfC and/or health-based guidance level*
    - *Index sums potential effects of multiple chemicals*
    - *Are these greater than 1?*
  - Cancer: Lifetime Excess Cancer Risk, multiple chemicals
    - *Are risks greater than 1 in a million ?*
    - *Are risks greater than 1 in 10,000 ?*

Hazard Indices by Health Endpoint: Near Wells, 20 Month Exposure Scenario



Risk Assessment Summary

- Residents living near well completion activities potentially exposed to substantial levels of air toxics
- Estimated cancer risks and chronic non-cancer hazard indices are greater for residents living nearest the well pads, but are within generally acceptable range.
- **Subchronic non-cancer cumulative and endpoint specific hazard indices are greater than one for residents living near well pads**.

Retrospective Cohort Study

McKenzie, L, et al. 2014. In Press, Environ Health Perspect; [Online January 28; DOI 10.1289/ehp.1306722].

Explore the association between a mother's proximity to natural gas development while pregnant and birth outcomes using:

- Birth certificate data
- Birth defects surveillance data
- Geocoded well locations
- Information on spud dates and gas production

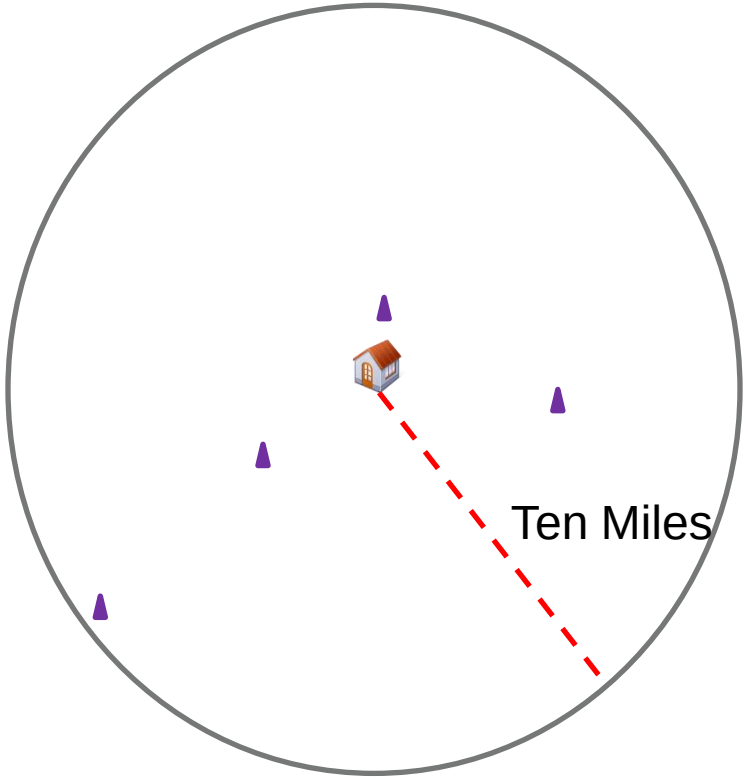
Birth Outcomes

- Congenital Heart Defects
- Neural Tube Defects (anencephalus and spina bifida)
- Oral Clefts (cleft lip and cleft palate)
- Preterm birth (less than 37 weeks of pregnancy completed)
- Term Low Birth Weight (less than 2500 grams ~ 5 pounds)

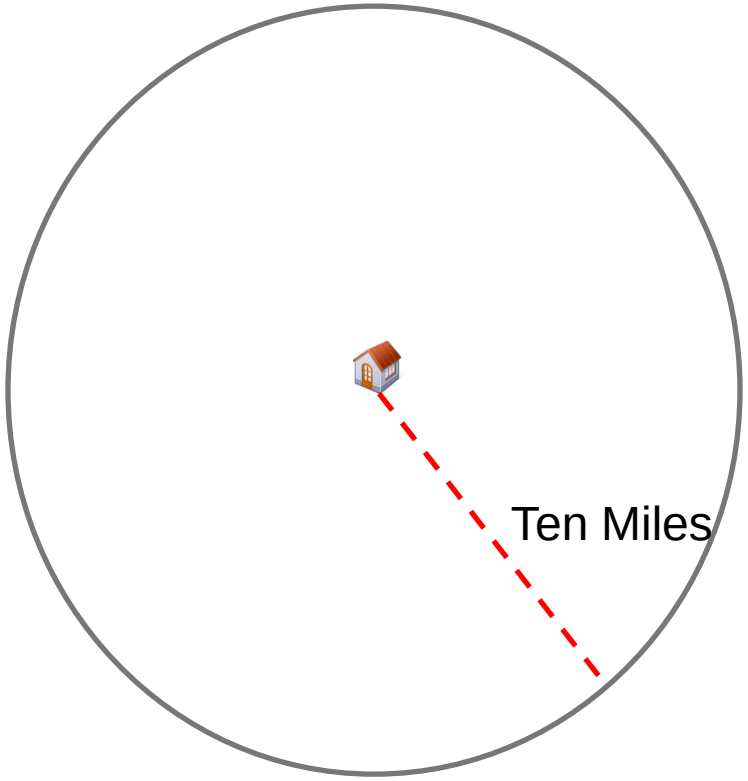
The Cohort

- 124,832 infants born between 1996 and 2009
- Rural areas and towns with populations less than 50,000
  - *Excluded: Denver-Metropolitan area, El Paso County and the cities of Fort Collins, Boulder, Pueblo, Grand Junction and Greely*
- White Hispanic and Non-Hispanic Mothers
- Singleton live births

Located all gas wells that existed in the infant's birth year within 10 miles of where the mother was living on the birth date of her infant

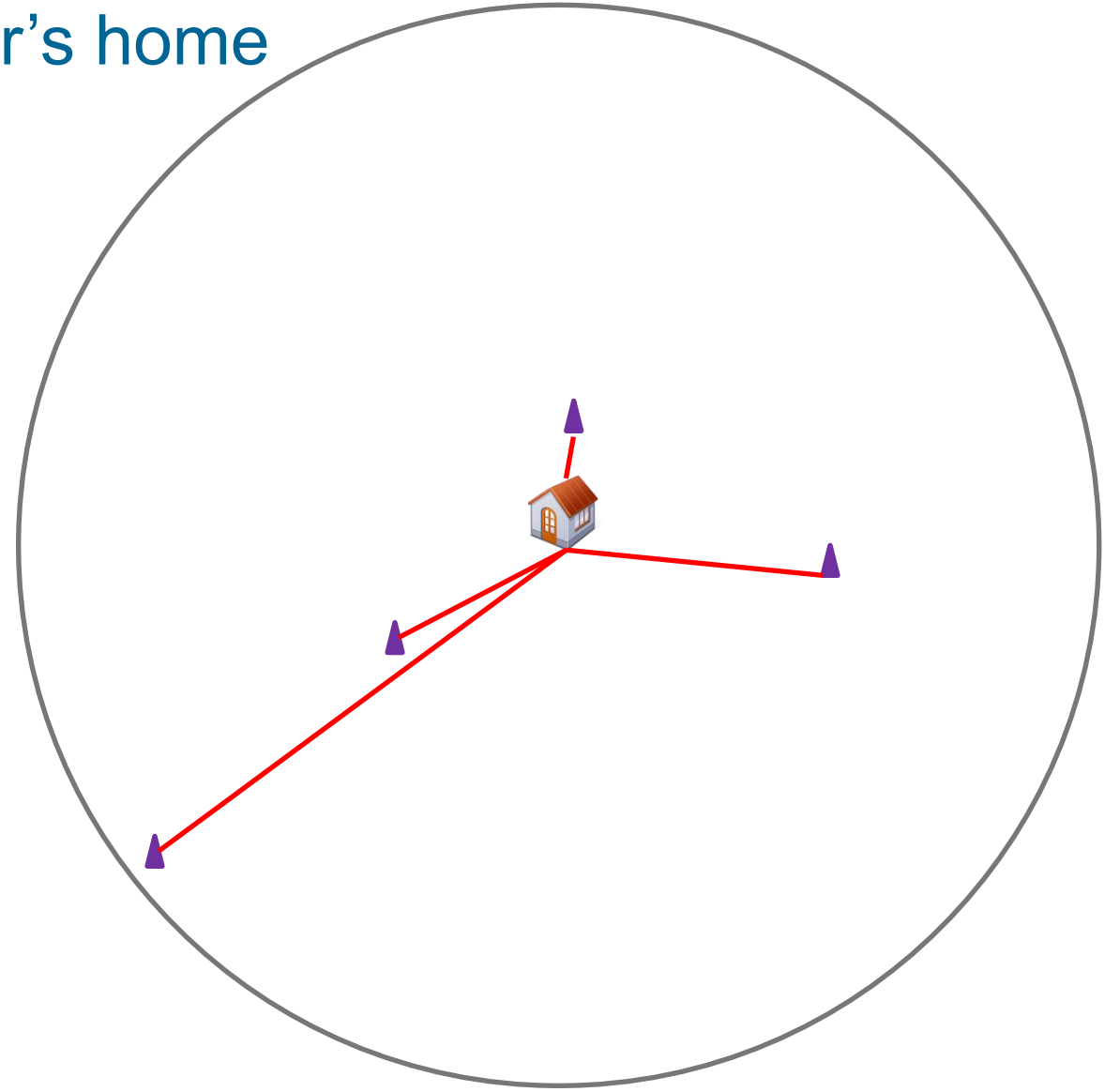


Exposed

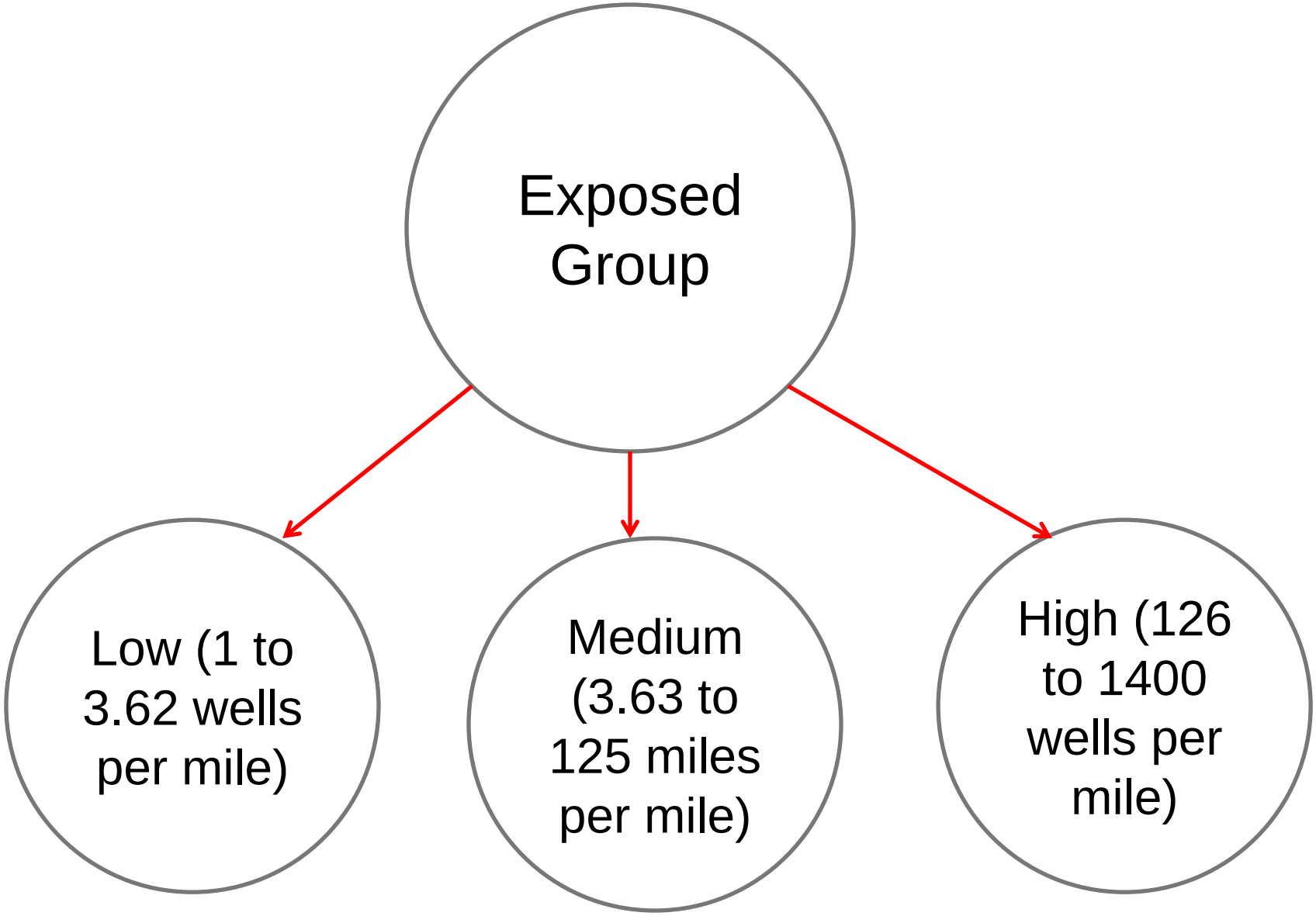


Unexposed

Measured the distance of each gas well from the Mother’s home



IDW Tertiles



Summary of Results

- Prevalence of CHDs increased with exposure tertile, with an odds ratio (OR) of 1.3 for the highest tertile (95% CI: 1.2, 1.5)
  - NTD prevalence was associated with the highest tertile of exposure (OR = 2.0, 95% CI: 1.0, 3.9, based on 59 cases), compared to no gas wells within a 10-mile radius.
- Exposure was negatively associated with preterm birth and positively associated with fetal growth, though the magnitude of association was small.
- No association was found between exposure and oral clefts.

Limitations

- Undercounting of birth defects possible
- Obscuring of outcomes by grouping
- Information on some potentially important confounders not available (e.g., maternal folate consumption)
- Exposure Misclassification
  - Maternal residence during the first trimester
  - Specific activities occurring at well sites

Conclusions

- Short term exposures to air emissions from well sites are potentially in the range of health concern for nearby residents
  - Health concerns include neurological, respiratory, and developmental effects.
- These results suggest a positive association between greater density and proximity of natural gas wells within a 10-mile radius of maternal residence and greater prevalence of CHDs and possibly NTDs, but not oral clefts, preterm birth, or reduced fetal growth.
- Further study is needed to address the limitations of this research

Public Policy Implications: Approaches for Minimizing Exposures and Potential Health Effects

HIA Recommendations/Best Management Practices

- **Pollution Prevention**
  - reduce the opportunity for residents to be exposed to industrial chemicals
- **Promote Safety**
  - promote safe industry operations in a residential neighborhood
- **Communication**
  - foster constructive interaction between stakeholders

Well Setback Rules: CO and TX

- "Old" CO Rules: 150/350 ft for rural/urban areas
- Feb 2013 Rules: 500 ft minimum, with mitigations for noise, etc; high occupancy buildings up to 1000 ft
- Fry, 2013: "In Texas, setbacks have no empirical basis, but are political compromises"
- New Colorado Methane emission control rules, March 2014

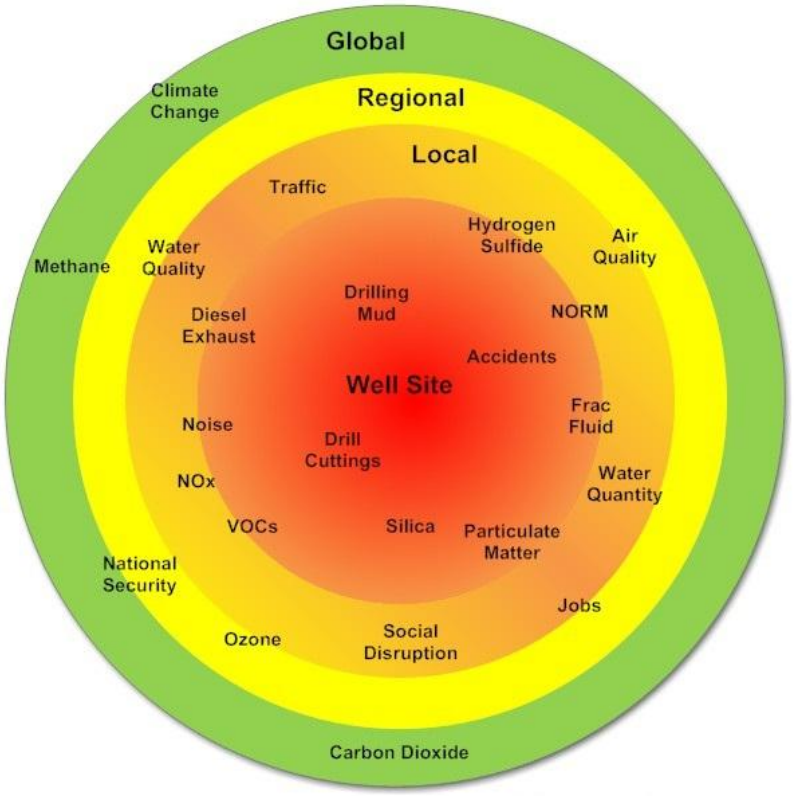
Photo credit: Denver Post, Hyoung Chang

Uncertainties, Limitations & Unanswered Questions

- Limited data exists on emissions to primary/secondary and engine-related air pollutants at during high emission processes, though this is changing:
  - Understanding spatial and temporal variability in human exposures is key to both prevention and investigating potential health outcomes
- Non-methane pollutant emissions vary by field type, number of well heads, well completion process used and controls in place
- **These data do not tell us how far is far enough nor how close is too close to well development sites**

In Closing

- While there is substantial public concern, it is likely many more people will live near gas and oil development sites in the future
- Research on control and mitigation strategies should focus on knowledge gaps and uncertainties



Acknowledgements

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- CSPH Colleagues: Lisa McKenzie, Roxana Witter, Lee Newman, Ken Scott, Kaylan Stinson