Baldwin Hills Health Assessment & Environmental Justice Study

October, 2024

Is Residence Near the Inglewood Oil Field Associated with A Higher Risk of Adverse Health Outcomes?

Residence near oil field

?

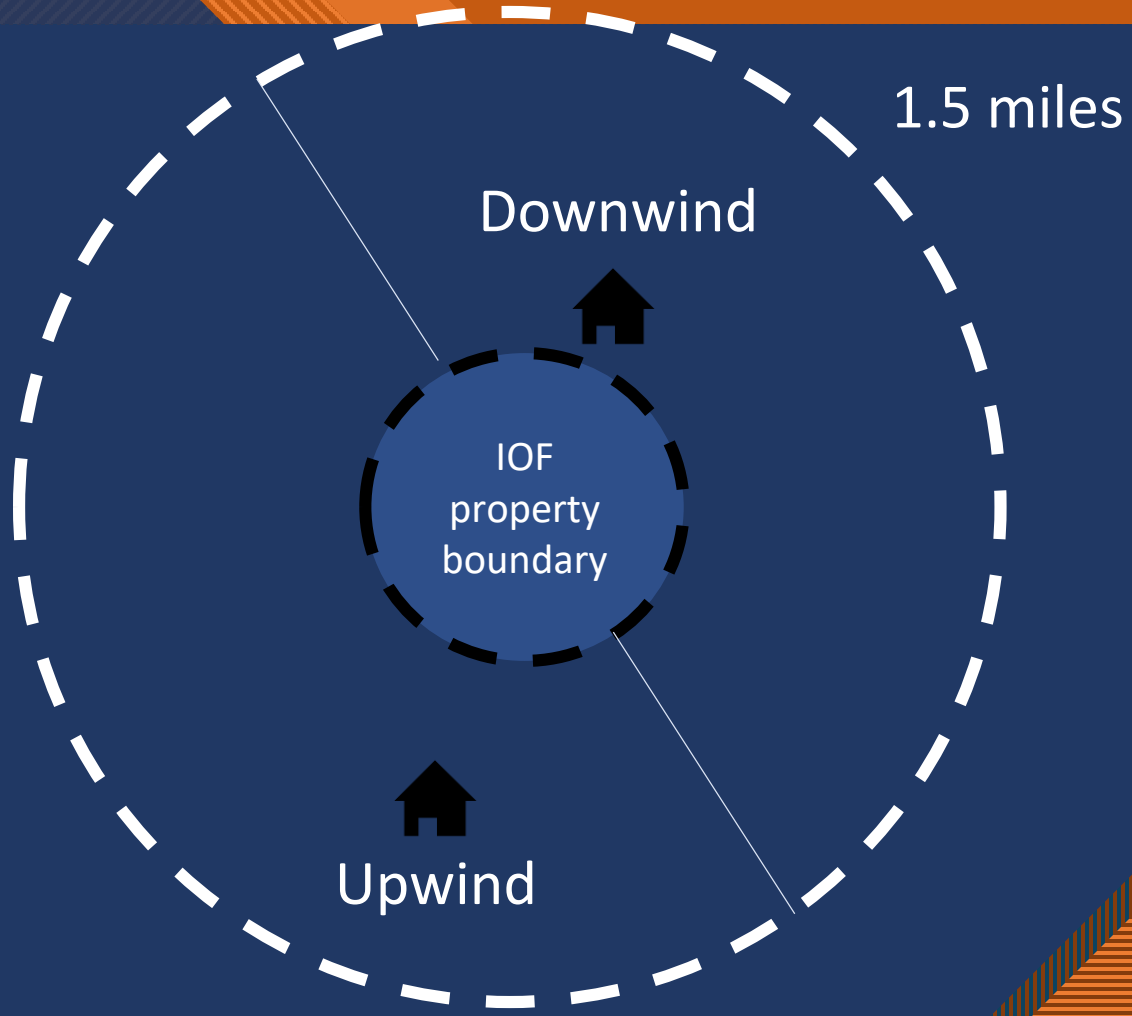
Measures of health

Study Population

People living within 1.5 miles of the Inglewood Oil Field (IOF) boundary

Wind direction

People living northeast of the IOF were classified as “downwind” based on the prevailing wind direction



Two Main Goals of the Study

1. Analysis of Historical Birth Records

- Includes all live births to parents living within 1.5 miles of the Inglewood Oil Field (IOF) between 2000-2019 (20 years, ~40,000 births)

2. New Health Survey & Biometric Data Collection and Analysis

- Includes 623 adults recruited between July 2023 and June 2024 who live within 1.5 miles of the IOF

Overview of Presentation

- Birth outcomes study and analysis results
- Health survey & biometric data collection and analysis results
- Overall conclusions & limitations
- Implications

Birth Outcome Study & Analysis

We focused on two outcomes that can impact the survival and health of infants and lead to long term respiratory, cognitive and other health problems

- Preterm birth – born too soon (less than 37 weeks)
- Small-for-gestational age – born too small (a measure of fetal growth restriction)

Created by Mahmure Alp from Noun Project

Rates of adverse birth outcomes were slightly higher than LA County

	0 – 1.5 miles (N=35,221)	**LA County** (N=2,711,173)
% Preterm birth*	7.9%	7.5%
% Small-for-gestational age*	9.0%	8.1%

* P<0.05 suggesting difference between the study area and LA county is not due to chance

Statistical test performed: 2-proportion z test

Rates of adverse birth outcomes did not vary substantially with distance to the oil field

- The group living between 0.5 and 1.0 mile of the IOF had the worst outcomes but we could not rule out that the differences were due to chance (P-values > 0.05)

	0 – 0.5 miles (N=3,096)	**0.5 – 1.0 miles** (N=8,919)	**1.0 – 1.5 miles** (N=23,206)
% Preterm birth	7.8%	8.2%	7.9%
% Small-for-gestational age	8.1%	9.6%	8.8%

Statistical test performed: chi-square test

Preterm birth rates are higher downwind (NE) as compared to upwind (SW) of the oil field

- Difference is biggest in the group living closest to the IOF

	0 – 0.5 miles (N=3,096)		**0.5 – 1.0 miles** (N=8,919)		**1.0 – 1.5 miles** (N=23,206)	
	Downwind	Upwind	Downwind	Upwind	Downwind	Upwind
% Preterm birth	9.8%*	6.4%	8.9%*	7.2%	8.5%*	7.1%
% Small-for-gestational age	7.6%	8.5%	10.1%	9.0%	8.9%	8.8%

* P<0.05 suggesting difference between downwind and upwind groups is not due to chance

Statistical test performed: 2-proportion z test

Non-Hispanic White parents had the lowest rates of preterm birth

- Rates of preterm birth decreased for Asian and Latinx parents with distance to the oil field
- Racial disparities remained at all distances, especially between Black and White parents

% Preterm birth	0 – 0.5 miles (N=3,096)	0.5 – 1.0 miles (N=8,919)	1.0 – 1.5 miles (N=23,206)
Black / African American	9.1%	10.0%	9.4%
Asian / Asian American	8.2%	7.7%	6.8%
Hispanic or Latinx	10.0%	8.2%	7.6%
Other	7.5%	7.5%	8.0%
White	4.6%	5.7%	5.9%

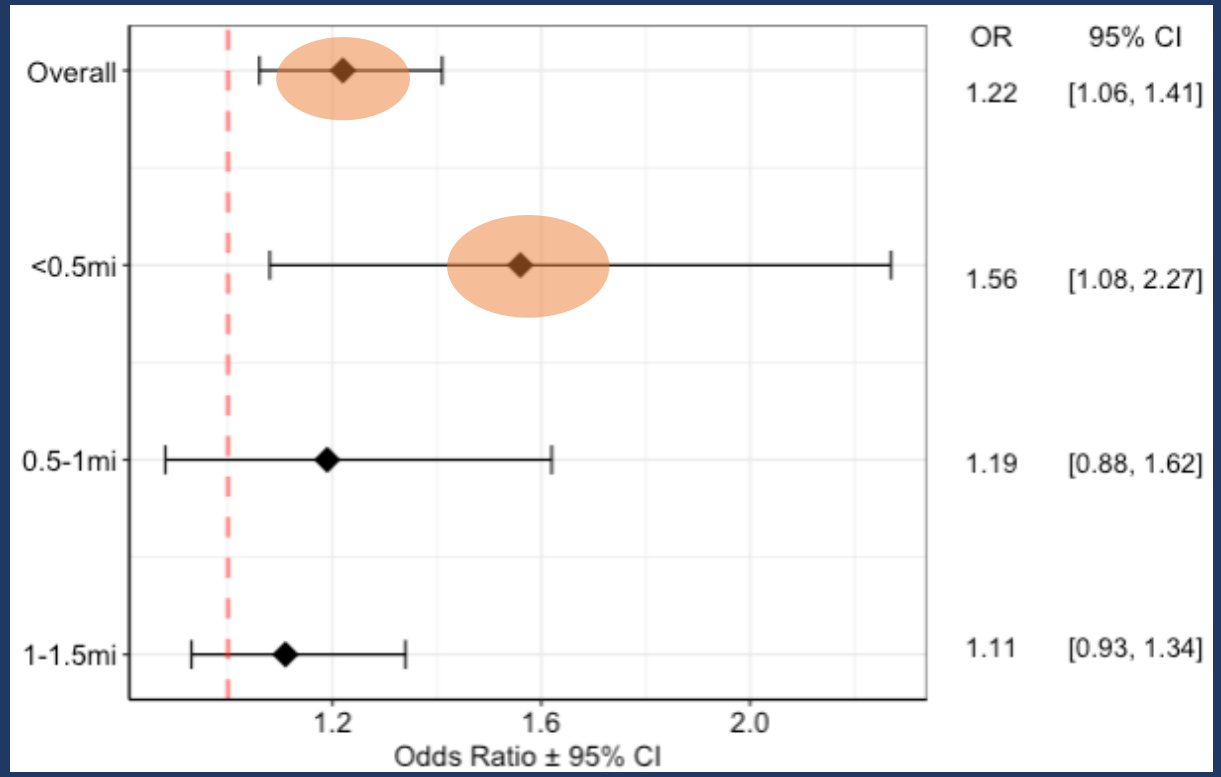
What could cause higher rates of preterm birth downwind and closer to the oil field?

1. Harmful exposures related to the oil field
2. Residents in these area have higher rates of other risk factors for preterm birth, such as older age or insufficient prenatal care

Statistical modelling techniques allow us to ‘control for’ other risk factors to better isolate the possible effects of the oil field

- Helps rule out alternative explanations for any associations we see between residence near & downwind of the oil field and preterm birth

After adjusting for other factors, living downwind of the oil field was still associated with a higher likelihood of preterm birth



Odds **of** preterm birth **was 56% higher for the group living within 0.5 miles of the IOF & downwind**, compared to those living within 0.5 miles and upwind

Analysis controls for age, parity, nativity, race/ethnicity, prenatal care, education, insurance, sex, season, year, neighborhood poverty rate, traffic, and amount of greenspace

Summary of Findings: Birth Outcomes

1. Communities living within 1.5 miles of the oil field have slightly worse birth outcomes than LA County as a whole
2. Among residents living within 0.5 miles of the oil field, living downwind was associated with a higher likelihood of preterm birth
   - the association was unlikely to be due to chance
   - the association was not explained by other risk factors like age, prenatal care or the amount of traffic near a person's home
3. We saw no evidence that living near or downwind of the oil field was associated with reduced fetal growth

Resident Health Survey and Biometric Data Collection & Analysis

Study Overview

- How we recruited:
  - Mailed letters to randomly chosen addresses (‘address-based sampling’)
  - Recruited in person from community sites (‘convenience sampling’)
- Who could participate:
  - People living within 1.5 miles of the IOF fence line
  - One adult (aged 18 or older) per household
- What we measured:
  - Biometric measures (blood pressure and lung function)
  - Self-reported health symptoms and chronic health conditions

Sample Representativeness of the Community

- We saw a higher response rate from White & college educated residents
- We saw a lower response rate from Latinos and non-college educated residents, particularly those with less than high school education

	Survey participants (N = 590)	Community within 1.5 miles of IOF
Race / Ethnicity		
African American	22.9%	27.2%
Asian	11.9%	9.6%
Hispanic/Latino	9.2%	31.7%
White	44.6%	25.7%
Other	11.5%	10.5%
Education		
Completed college or higher	81.2%	47.4%
HS graduate / some college	16.5%	40.1%
Less than HS	1.2%	12.4%

Note: Community demographics are derived from the American Community Survey (ACS) 2022 5-yr block group level estimates. The educational attainment in the ACS sample is among only those who are 25 years or older.

What do blood pressure numbers mean?

- ***Systolic* blood pressure** measures the pressure in your arteries when your heart beats.
- ***Diastolic* blood pressure** measures the pressure in your arteries when your heart rests between beats.

	Systolic (mm Hg)	Diastolic (mm Hg)
High (hypertension)	130 or higher	or 80 or higher
Elevated	120-129	and <80
Normal	<120	and <80

Source: https://www.cdc.gov/high-blood-pressure/about/index.html
Whelton PK, et al. (2017). *J Am Coll Cardiol*. 2018;71(19):e127–e248.

Average Blood Pressure and Hypertension Rates

- Rates of high blood pressure were similar to LA county
- Participants living 0.5-1.0 miles had the lowest hypertension rate
- Participants living nearer to the oil field (0-1 miles) had slightly lower diastolic pressure on average

We defined high BP as: SBP >130 mmHg or DBP > 80 mmHg

	0-0.5 miles (N=190)	0.5-1.0 miles (N=211)	1.0-1.5 miles (N=130)	LA County (2015-2018) ▵
High BP	46.3%	39.8%	46.9%	44.2%
Average Diastolic BP*	76.9	75.4	78.1	/
Average Systolic BP	121.0	119.0	122.9	/

* P<0.05 suggesting difference among different distances is not due to chance
▵ the LA county high BP is defined as SBP >130 mmHg or DBP > 80 mmHg or currently taking hypertension medications

Statistical test performed: Chi squared (high BP) and ANOVA (diastolic and systolic)
Source: https://www.cdc.gov/nchs/data/hestat/hypertension-15-18/hypertension-15-18.pdf

Blood Pressure by Wind Direction

- Among residents living within 0.5 miles of the IOF, average diastolic blood pressure and the rate of high blood pressure were higher in the downwind vs. upwind direction

	0 – 0.5 miles (N=190)		**0.5 – 1.0 miles** (N=211)		**1.0 – 1.5 miles** (N=130)	
	Downwind	Upwind	Downwind	Upwind	Downwind	Upwind
% High BP	56.9%*	40.8%	40.8%	37.5%	55.7%	39.7%
Average Diastolic BP	79.1*	75.8	74.9	76.6	79.2	77.5
Average Systolic BP	124	120	119	117	124	120

* P<0.05 suggesting difference between downwind and upwind groups is not due to chance

African Americans had the highest rate of high blood pressure

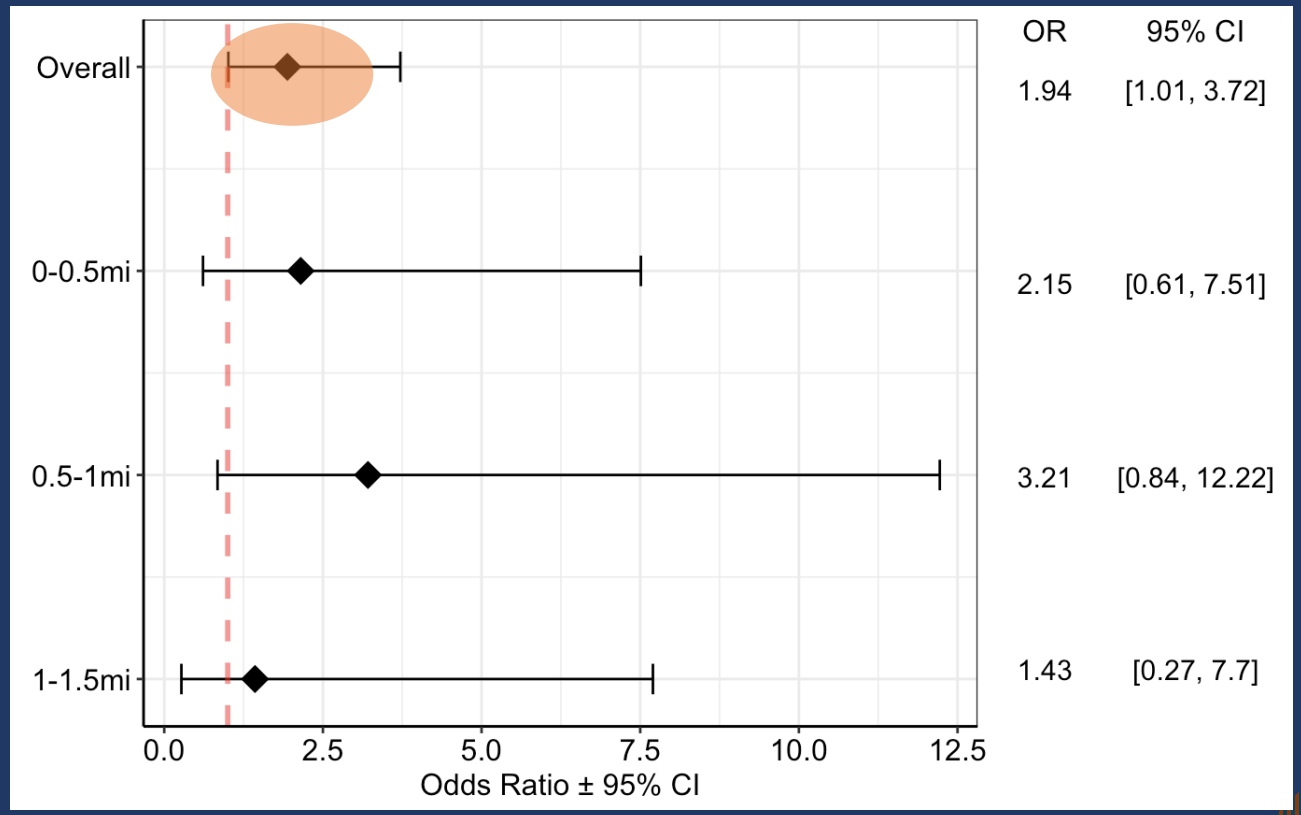
- Among African American, Asian, and Hispanic participants, the highest rates of high blood pressure were observed closest to the oil field (0-0.5 miles)
- For White participants, rates of high blood pressure increased with distance to the oil field

% High BP	0-0.5 miles (N=190)	0.5-1.0 miles (N=211)	1.0-1.5 miles (N=130)
Black / African American (N=103)	64.1%	44.2%	61.9%
Asian / Asian American (N=57)	52.2%	44.4%	25.0%
Hispanic or Latinx (N=40)	42.9%	37.5%	41.2%
Other (N=59)	47.6%	36.4%	56.3%
White (N=230)	36.0%	34.4%	51.1%

Summary Blood Pressure Analysis Controlling for Covariates

- **Hypertension Rates Associated with Wind Direction:** Downwind is associated with increasing likelihood of hypertension after adjustments (p = 0.048). However, how close someone lives to the IOF did not seem to influence this outcome.

- Men, older, overweight participants, and those with a previous hypertension diagnosis were more likely to have higher blood pressure.



**The adjusted models are adjusted for age, sex, race/ethnicity, education, hypertension diagnosis, years living in the neighborhood, BMI, ever smoker, gas stove, greenspace and traffic.*

Lung Function Measures

- **Forced expiratory volume in one second (FEV1):** The volume of breath exhaled with effort in one second.
- **Forced vital capacity (FVC):** The full amount of air that is exhaled with effort in a complete breath
- Definition of normal lung function by spirometry: an FEV1/FVC ratio of greater than 0.70 and both FEV1 and FVC above 80% of the predicted value (adjusted for age, gender and height).

Spirometry Test	NORMAL	ABNORMAL
FVC and FEV1	Equal to or greater than 80%	Less than 80%
FEV1/FVC	Equal to or greater than 70%	Less than 70%

https://www.ncbi.nlm.nih.gov/books/NBK482339/
http://www.worker-health.org/breathingtestresults.html#:~:text=If%20the%20FVC%20and%20the,a%20more%20severe%20lung%20abnormality.

Average and Abnormal Lung Function Rates

- Participants living nearest to the oil field had the highest rate of abnormal lung function
- Participants living nearer to the oil field had the lower average FEV1 and FVC
- We could not rule out that these differences were due to chance (all P-values > 0.05)

	0 – 0.5 miles (N=163)	**0.5 – 1.0 miles** (N=191)	**1.0 – 1.5 miles** (N=110)
Abnormal lung function	66.9%	62.8%	62.7%
Average FEV1	2.20	2.42	2.62
Average FVC	2.49	2.81	3.02

Statistical Test Used: Chi-square test and ANOVA test

Average and Abnormal Lung Function by Wind Direction

- A higher rate of abnormal lung function was observed in downwind participants living 0.5-1.5 miles, but we could not rule out that this was due to chance.
- FEV1 and FVC were lower on average among downwind vs. upwind participants living 0.5-1.5 miles from the oil field

	0 – 0.5 miles (N=163)		**0.5 – 1.0 miles** (N=191)		**1.0 – 1.5 miles** (N=110)	
	Downwind	Upwind	Downwind	Upwind	Downwind	Upwind
Abnormal lung function	66.7%	67.0%	66.2%	55.2%	72.3%	55.6%
Average FEV1	2.29	2.24	2.31*	2.64	2.32*	2.85
Average FVC	2.59	2.53	2.64*	3.11	2.74*	3.25

* P<0.05 suggesting difference between downwind and upwind groups is not due to chance

Statistical Test Used: Two-proportional z test, two-sample t test

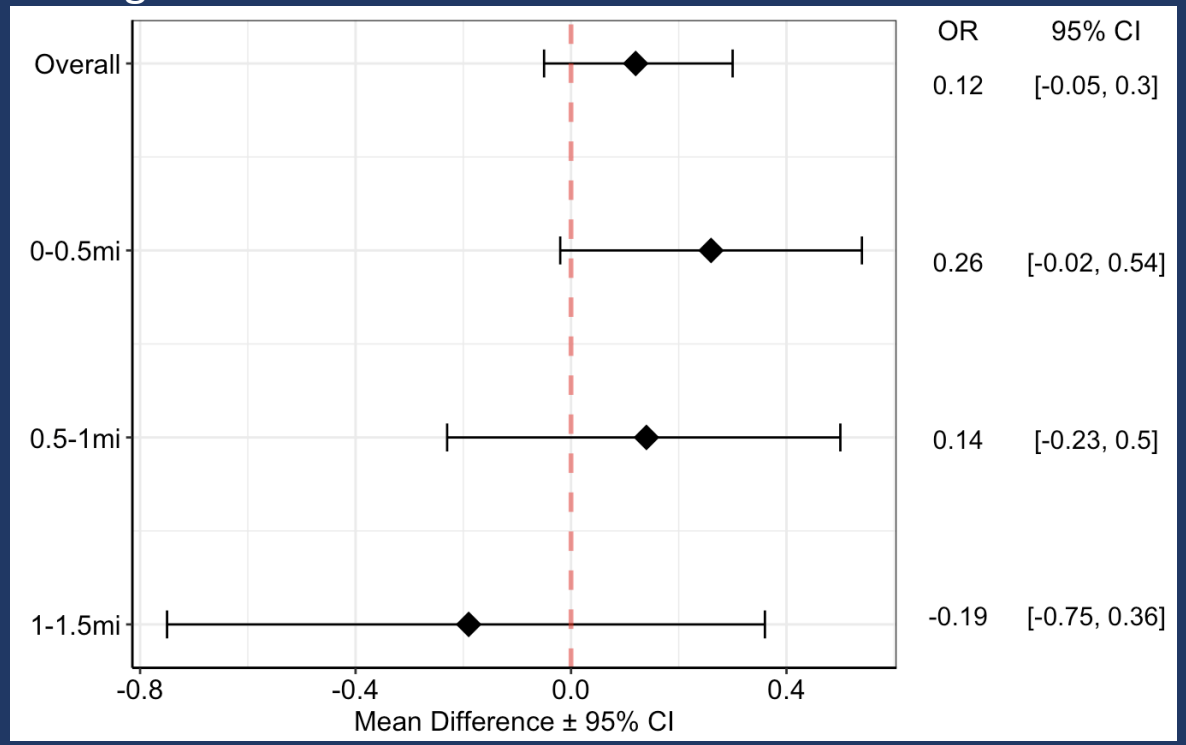
Disparate Impact of Distance on Abnormal Lung Function Among Different Race/Ethnicity Groups

- Consistent increase of abnormal lung function rate for Black/African American Individuals living further away from IOF
- Hispanic or Latinx and Asian/Asian American groups show varied responses to increasing distance from IOF, White individuals exhibit a decreasing trend

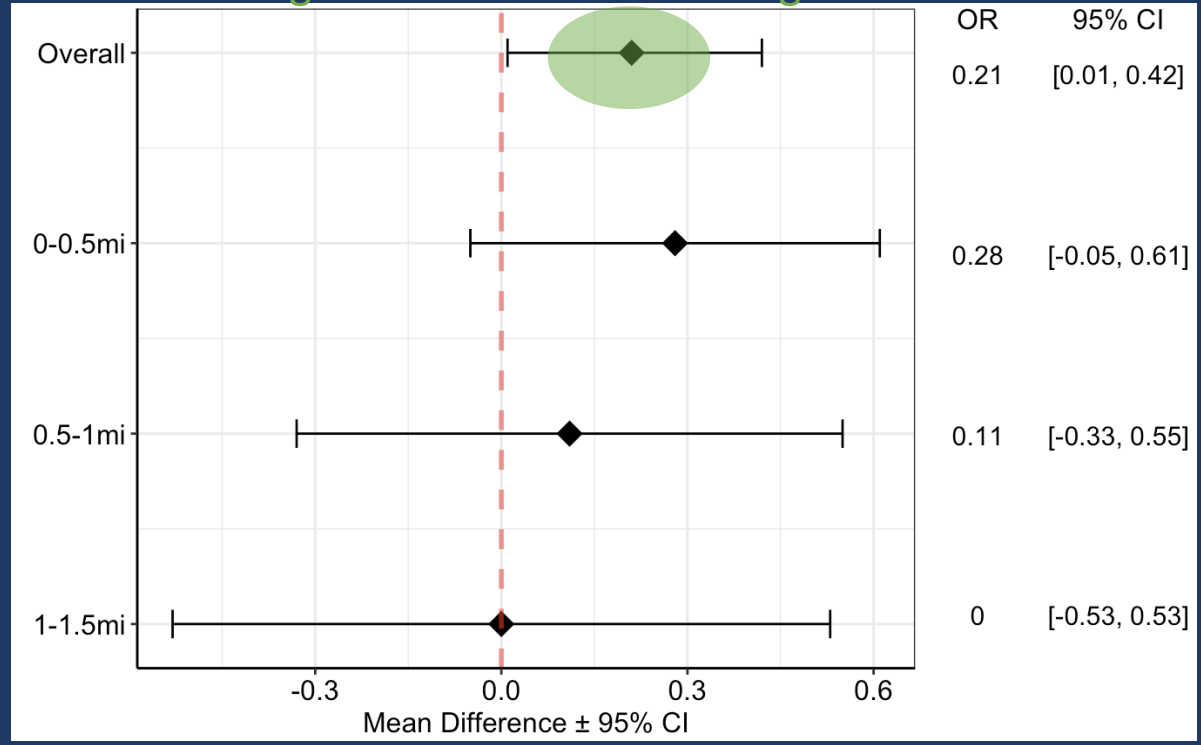
% Abnormal Lung Function	0 – 0.5 miles (N=163)	0.5 – 1.0 miles (N=191)	1.0 – 1.5 miles (N=110)
Black / African American (N=100)	83.3%	86.4%	95.0%
Asian / Asian American (N=55)	71.4%	55.6%	68.8%
Hispanic or Latinx (N=34)	40.0%	71.4%	60.0%
Other (N=59)	71.4%	45.5%	56.3%
White (N=216)	58.8%	55.9%	48.8%

Average FVC was higher among downwind participants after adjustment for other factors

No significant effect of wind direction for FEV1



Residents living downwind showed a slight increase in FVC



**Models are adjusted for age, sex, race/ethnicity, asthma diagnosis, recent flu/cold, years living in the neighborhood, BMI, season, ever smoker, gas stove, ever positive for COVID-19, greenspace and traffic*

Effects of Demographics, Health, and Environmental Factors on Lung Function

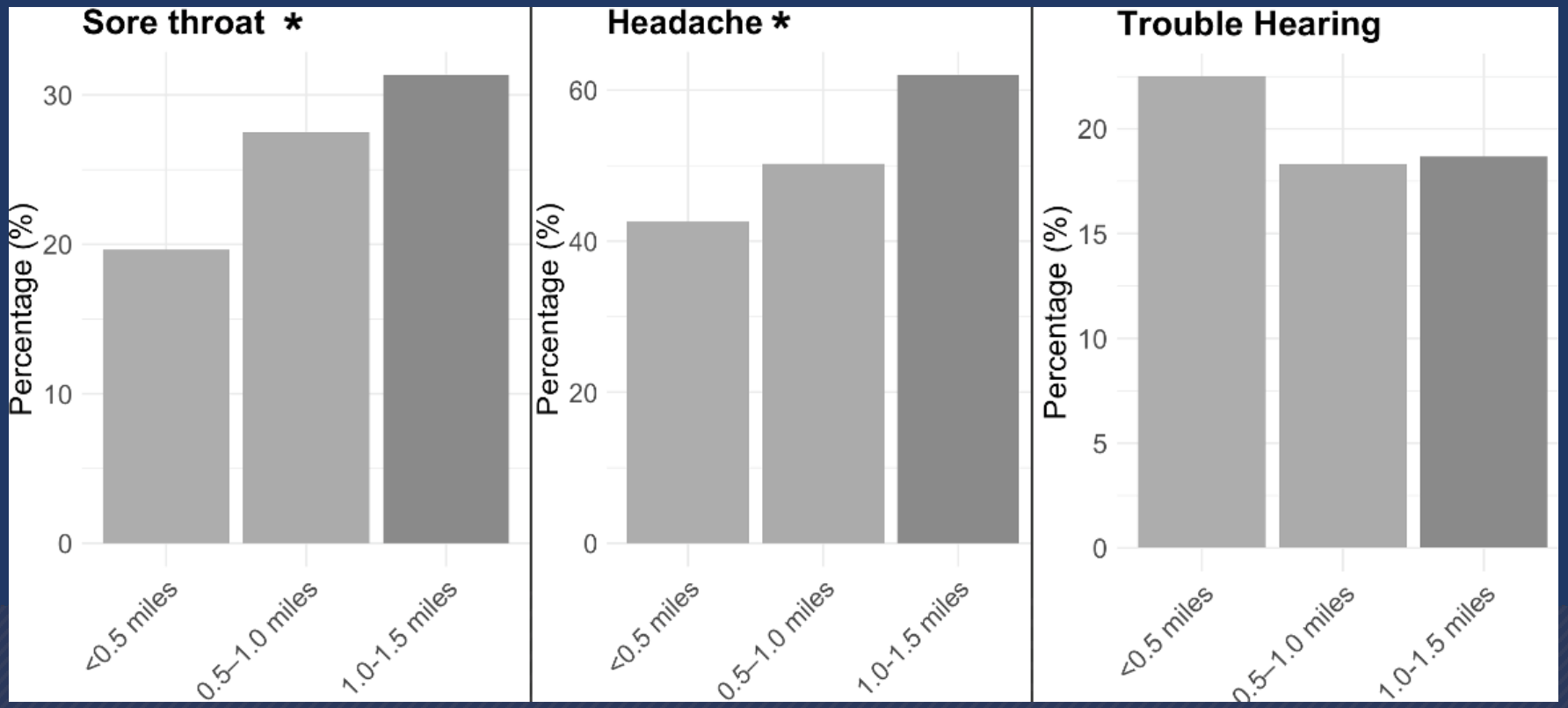
- **Demographic Influences:**
  - **Age and Residence Duration:** Linked to decreased lung function, pointing to possible long-term environmental or aging effects.
- **Health Factors:**
  - **No statistically significant impact:** Smoking history, asthma, recent cough, previous COVID-19 infection, and body mass index showed limited impact on lung function.
- **Environmental Factors:**
  - **Seasonal Variation:** Lung function was worse during winter months.
  - **Traffic and Green Spaces:** No noticeable effects on lung function observed.

Self-reported Symptoms

- Examined 23 symptoms participants might have experienced in the past 2 weeks
- Most commonly reported symptoms in the community are:
  - Sneezing or runny nose
  - Fatigue
  - Irritation of the eyes/watery eyes
  - Headache

Participants living closer to the oil field were less likely to report health symptoms

- Sore throat and headache were less frequently reported among residents nearer to the oil field*
- Trouble hearing was reported more frequently among residents living nearest the oil field, but this difference was not statistically significant at P<0.05



* P<0.05 suggesting difference between the three distance groups is not due to chance

Statistical test performed: Chi-square test

Summary of Self-reported Symptoms

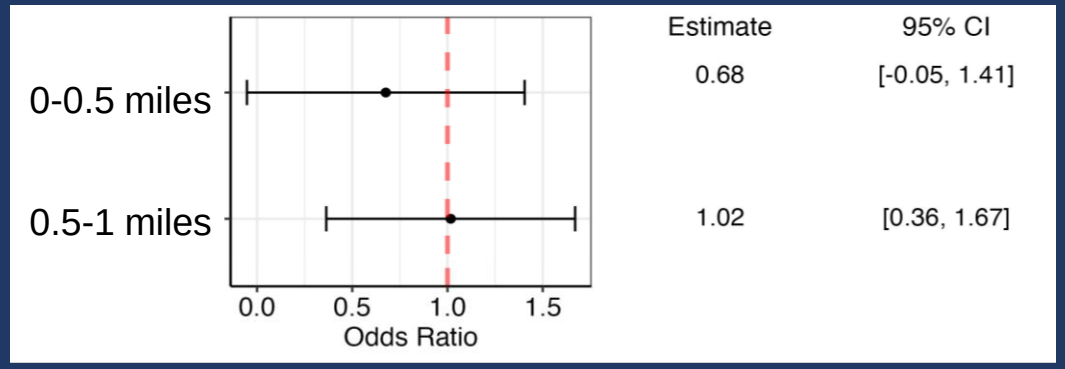
- After adjustment for other factors, there were no longer any statistically significant differences between distance to the oil field and symptoms reported.
- Men were less likely to report any of the symptoms compared to women.
- Older participants were less likely to report sore throat and headache.
- Higher BMI was associated with a slight increase in the likelihood of reporting each symptom, suggesting weight may influence symptom occurrence.

**Models are adjusted for age, sex, race/ethnicity, education, asthma diagnosis, years living in the neighborhood, hours outdoor, BMI, season, ever smoker, gas stove, greenspace and traffic*

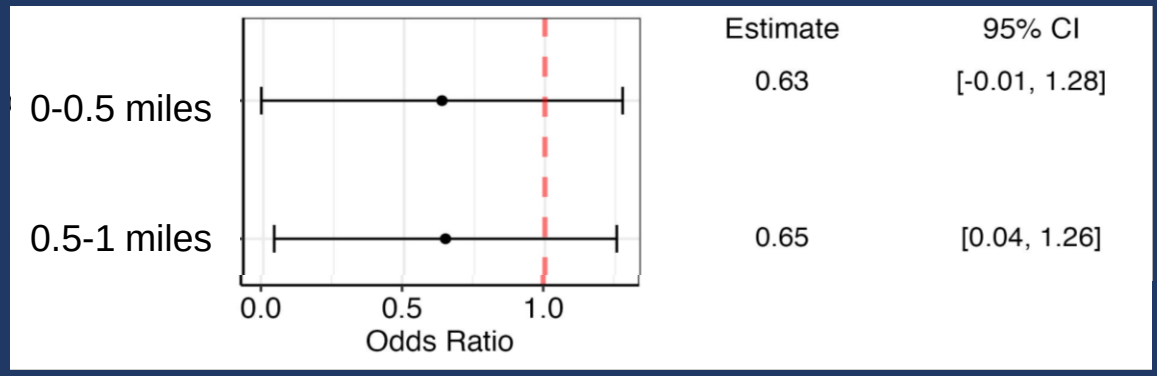
No Obvious Distance Effect on Sore Throat and Headache

No significant difference in the likelihood of experiencing sore throat, headache, and trouble hearing in the last two weeks for residents living within 0.5 miles, 0.5-1 miles compared to those who live 1-1.5 miles

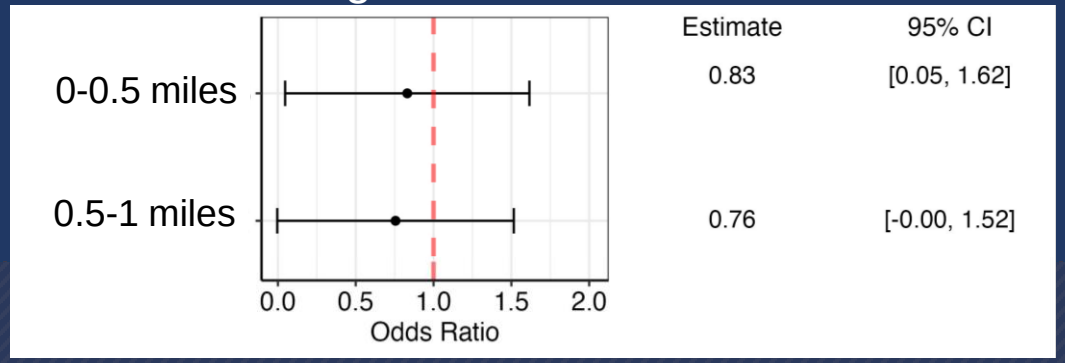
Sore Throat



Headache



Trouble Hearing



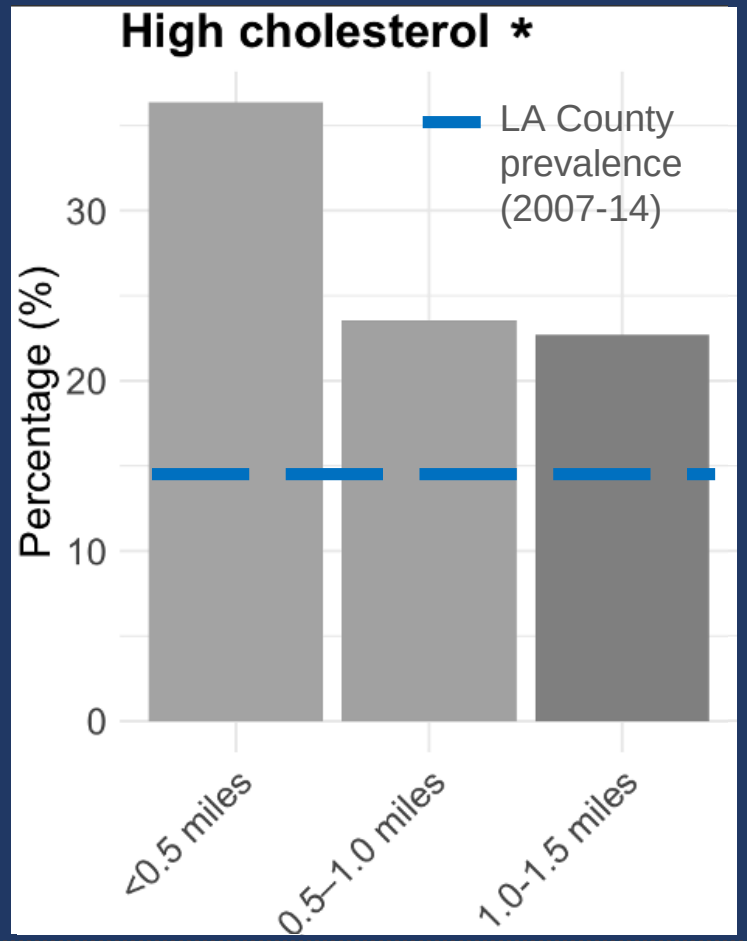
**Models are adjusted for age, sex, race/ethnicity, asthma diagnosis, recent flu/cold, years living in the neighborhood, BMI, season, ever smoker, gas stove, ever positive for COVID-19, greenspace and traffic*

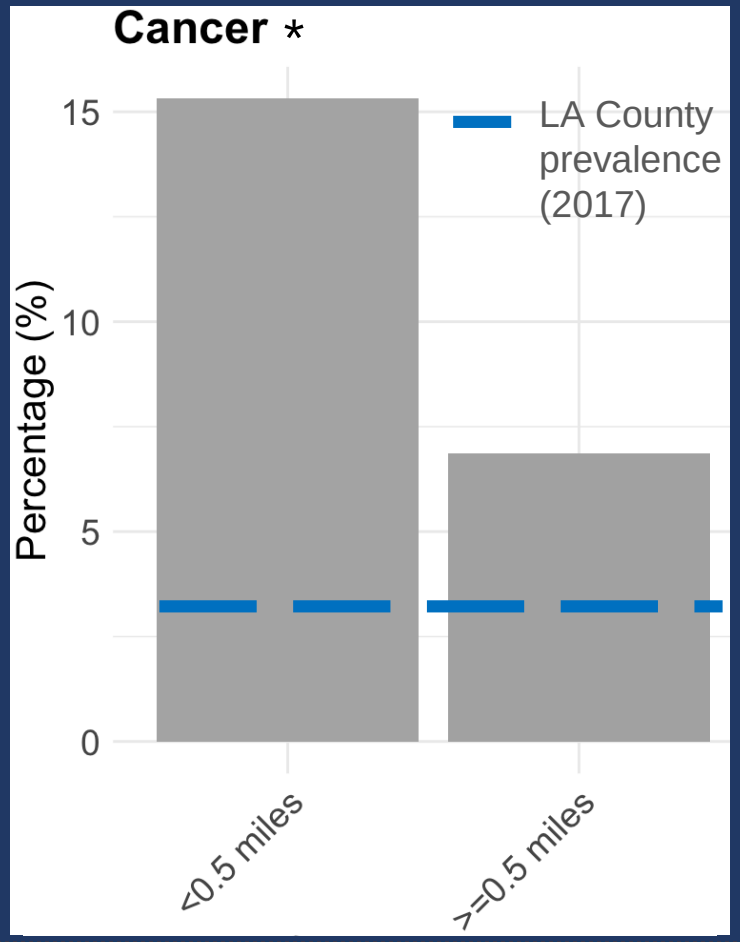
Self-reported Health Conditions by Distance

- Most frequently reported health conditions among participants: high cholesterol, cancer, heart problems, miscarriage, allergies, chronic obstructive pulmonary disease (COPD), chronic bronchitis, pneumonia.*
- High cholesterol and cancer were more common among residents living nearer to the oil field**
- Most commonly reported cancer types: breast and skin

*Respondents were asked about their own cholesterol and cancer rates.
For all other conditions, we asked whether anyone in the household had the condition
**P<0.05 suggested differences were unlikely to be due to chance. Statistical Test Used: Chi-square test

Self-reported Health Conditions by Distance





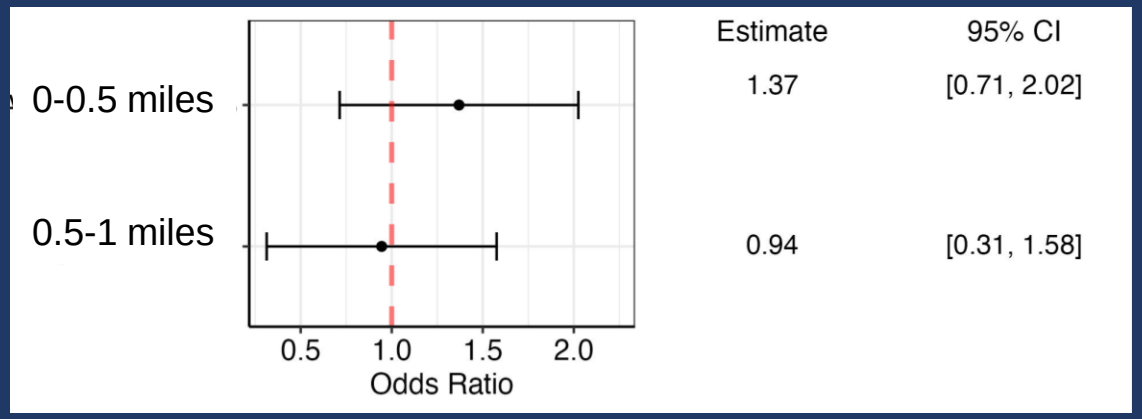
High cholesterol and cancer were more common among residents living nearer to the oil field

Sources: https://health.ucdavis.edu/cancer/pdfs/CancerPrevalenceInCaliforniaCounties2017.pdf
https://www.cdc.gov/nchs/data/hestat/lipidlevels/abnormal-lipid-levels.htm#Table2

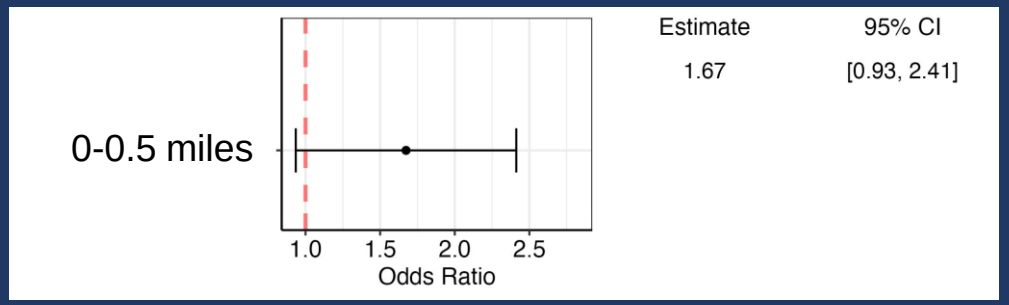
Associations were no longer observed after accounting for other risk factors

Living closer to the oil field was no longer associated with an increased likelihood of either high cholesterol or cancer

High Cholesterol (comparing to 1-1.5 miles)



Cancer (comparing to 0.5-1.5 miles)



**Models are adjusted for age, sex, race/ethnicity, education, ever smoker, BMI, gas stove usage, outdoor hours, years living in the neighborhood and traffic*

Summary of Findings: Biometric Measures

1. After adjustments, living downwind was associated with an increased likelihood of high blood pressure ($p = 0.048$).

2. Lung function was lower among participants living closest to the oil field and lower in the downwind direction
   - These differences went away after accounting for other risk factors.

3. After accounting for other factors, living downwind of the oil field was associated with better FVC
   - Unclear what could cause this.

Summary of Findings: Health Survey

1. After controlling demographics, health and environmental factors, reported sore throat and headache were no different between participants living across different distances to the oil field

2. After controlling demographics, health and environmental factors, reported high cholesterol and rate of cancer were no more different among participants living across different distance to the oil field

Conclusions

1. Our analysis suggests the oil field may have increased the risk of preterm birth among residents living nearby and downwind

    - We cannot rule out the possibility that our finding is explained by some other factor we were unable to measure
    - However this finding is consistent with other studies of oil and gas development in California's Central Valley, Pennsylvania, and Texas
    - Our study was unable to assess miscarriage, and therefore may have underestimated health impacts

Conclusions

2. We have limited evidence to suggest residence near the oil field is associated with increased blood pressure and better lung function
    - The blood pressure finding is consistent with a prior study in another Los Angeles neighborhood near oil development
    - The lung function finding is inconsistent with a prior study in Los Angeles, and may be due to other limitations of our study such as the under-representation of less educated and Latinx residents
    - Study limitations, such as lack of information about if a participant was/is being treated for a respiratory disease, may mean we did not detect an impact that does exist

Johnston, J. E., et al. (2024). *Journal of exposure science & environmental epidemiology*, *34*(3), 505–511. https://doi.org/10.1038/s41370-023-00589-z
Johnston, J. E., et al. (2021). *Environmental Research*, *197*, 111088. https://doi.org/10.1016/j.envres.2021.111088

Conclusions

3. We do not have sufficient evidence to suggest residence near the oil field increased the risk of cancer or high cholesterol

   - Cancer takes a long time to develop. Because of this and other study limitations like our modest small sample size, it is possible there is an association between residence near the oil field and cancer that we were unable to detect
   - Prior studies in Colorado and Texas have linked residence near oil and gas development with higher incidence of childhood cancers, but no prior studies have assessed populations in California
   - Our study relied on self-reported health conditions that have not been verified via a review of medical records

Recommendations

- Programs to support pregnant people could benefit the community given the higher rates of adverse outcomes compared to LA County as a whole, and suggestive evidence of an adverse effect of the oil field on preterm birth
- The risk for developing cancer is complicated and causes of cancer in a single community are difficult to detect. Future research would be best conducted in a larger population (e.g. in regions or entire CA)
- Future studies to measure contaminants in people bodies (biomonitoring) could help clarify whether people are being exposed to specific pollutants associated with oil drilling

THANK YOU

QUESTIONS?