Baldwin Hills 2nd Health Assessment and Environmental Justice Study

Executive Summary

Background and Objectives

The Baldwin Hills Health Assessment and Environmental Justice (BHHAEJ) study sought to evaluate the health of residents living near the Inglewood Oil Field (IOF) in Los Angeles County (LAC) by characterizing health outcomes for nearby communities, assessing environmental justice concerns, and engaging local stakeholders to provide input on study design, materials, process, and methods. In accordance with the priorities identified by a Steering Committee of community advocates and external experts, the BHHAEJ project included two components: (1) a historical analysis of birth outcomes utilizing administrative birth records; (2) a survey of health symptoms and conditions, assessment of present-day blood pressure and lung function among nearby residents. In each of these components, we investigated the overarching question: Is residence near or downwind of the IOF associated with a higher risk of adverse health outcomes?

Methods

For the analysis of birth outcomes, we obtained administrative birth records for all live births to parents living within 1.5 miles of the IOF between 2000-2019. We used information on gestational age and birthweight to identify preterm births (<37 completed weeks) and births that were small-for-gestational age (SGA), a measure of fetal growth restriction. For the survey and biometric analyses, we recruited 623 adults residing within a 1.5-mile radius of the IOF using a combination of random and convenience sampling via mail, community outreach and recruitment events, and social media ads, between July 2023 and June 2024. Participants completed a survey that included questions about health symptoms and chronic health conditions. Study staff measured each participant's blood pressure and lung function using a spirometry test. For both study components, we geo-coded participant's residential addresses to assess residential proximity and wind direction relative to the oil field. People living northeast of the IOF were classified as "downwind" based on the prevailing southwest wind direction. Statistical modeling was used to estimate the association between residential proximity (<0.05 miles, 0.5-1.0 miles, or 1.0-1.5 miles) and wind direction (downwind or upwind) and the health outcomes while controlling for potential confounders. We classified effect estimates with a p-value < 0.05 as statistically significant.

Results

Birth Outcome Analysis

Residents living within 1.5 miles of the oil field between 2000-2019 had slightly higher rates of adverse birth outcomes (7.9% preterm birth, and 9.0% SGA) compared to LAC overall (7.5% and 8.1%, respectively). Racial disparities existed in the IOF community, with non-Hispanic White parents having lower preterm birth rates (5.9%) compared to Black/African American parents (10.6%), Asian parents (7.5%), Hispanic/Latinx parents (8.6%), other race/ethnicity parents (8.1%).

The preterm birth rate was higher in the community living downwind of the oil field as compared to upwind, while the rate of SGA was similar. The difference in overall preterm birth rates was most pronounced closest to the oil field (<0.5 miles), where the rate was 9.8% downwind versus 6.4% upwind. The trend persisted at greater distances, with preterm birth rates of 8.9% downwind versus 7.2% upwind within 0.5–1.0 miles, and 8.5% downwind versus 7.1% upwind within 1.0–1.5 miles. After adjusting for infant sex, parent age, parity (the total number of births), nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate, living downwind remained associated with a higher likelihood of preterm birth. Specifically, within 0.5 miles of the oil field, the odds of preterm birth were 56% higher downwind than upwind (OR=1.56, 95% CI =[1.08, 2.27]). The odds of preterm birth also decreased after the implementation of stricter regulations at the oil field in 2008. However, our analysis does not provide sufficient evidence to suggest changes in regulation reduced preterm birth risks because we saw no variation in our effect estimates with distance to the oil field and a similar decline in the preterm birth rate was seen across Los Angeles County as a whole over this time period. We found no evidence living nearer or downwind of the oil field was associated with reduced fetal growth (SGA) in adjusted analyses.

Resident Health Survey

Survey participants were between the ages of 18 and 92. Almost half (44.6%) identified as non-Hispanic White, 22.9% identified as African American, 11.9% as Asian, 9.2% as Hispanic/Latinx, and 11.5% as other. Hispanics and those without a college education were relatively under-represented in our study compared with the community demographics estimated using the American Community Survey, which may reflect our efforts to oversample neighborhoods closer to the oil field (which are demographically less Hispanic) as well as lower response rates within the Hispanic community. Five hundred ninety (590) participants completed the health survey, 540 completed the biometric measurements, and after data cleaning the resulting analytic sample consisted of 464 respondents with complete data.

We examined 23 symptoms that participants reported experiencing in the past two weeks. The most commonly reported symptoms included sneezing or runny nose, fatigue, irritation of the eyes/watery eyes, and headaches. Participants living closer to the oil field 0-0.5 miles) were less likely to report sore throat and headaches than participants living further away (0.5-1 miles and 1-1.5 miles). However, after adjusting for other factors (age, sex, race/ethnicity, education, smoking history, diagnosed asthma, body mass index (BMI), usage of gas stove, traffic, hours spent outdoor, years of residence, season, and green space), these differences were no longer statistically significant. Men were less likely to report any of the symptoms compared to women, and older participants were less likely to report sore throat and headaches. Additionally, a higher BMI was associated with a slight increase in the likelihood of reporting symptoms, suggesting that body weight may influence symptom occurrence.

The most frequently self-reported health conditions included high cholesterol, cancer of all types, heart problems, miscarriage, allergies, chronic obstructive pulmonary disease (COPD), chronic bronchitis, and pneumonia. Notably, high cholesterol and cancer were more commonly reported among residents living closer to the oil field (0-0.5 miles), with breast and skin cancers being the most frequently reported types. However, after accounting for other factors (age, sex, race/ethnicity, education, smoking history, BMI, gas stove, traffic, outdoor hours, years of residence), the associations between proximity to the oil field and these conditions were no longer statistically significant. Also, while we asked about cancer in general, there is no evidence that exposure to oil and gas operations is a risk factor for many types of cancer.

Biometric Data Analysis

We found the mean diastolic blood pressure (DBP) levels were different across varying residence distances from the IOF. Mean systolic blood pressure (SBP) remained similar across distances, and rates of hypertension were similar to LAC averages. In contrast, the influence of wind direction was more pronounced, particularly for residents within 0-0.5 miles of the IOF. Downwind residents living within 0-0.5 miles of the IOF had significantly higher DBP and a higher prevalence of hypertension compared to upwind residents, with 56.9% of downwind residents classified as hypertensive versus 40.8% upwind. After controlling other factors (age, sex, race/ethnicity, hypertension diagnosis, years living in the neighborhood, BMI, season, smoker, gas stove, green space, and traffic), the associations between IOF proximity, wind direction, and blood pressure were no longer statistically significant. The odds of high blood pressure were 94% higher (OR [95% confidence interval or CI] = 1.94 [1.01,3.72]) for downwind relative to upwind residents living within 1.5 miles after adjustment. Associations between wind direction and HBP were, however, not statistically significant in distance specific analyses (i.e., 0 – 0.5 miles, 0.5 – 1.0 miles, and 1.0 – 1.5 miles).

A higher rate of abnormal lung function was observed among downwind participants living 1–1.5 miles from the oil field. On average, downwind participants had lower Forced Expiratory Volume in 1 second (FEV1) and Forced Vital Capacity (FVC) compared to upwind participants in the same distance range. For example, within 0.5-1 miles, the average FEV1 was 2.32 liters downwind versus 2.64 liters upwind, and the average FVC was 2.64 liters downwind versus 3.11 liters upwind. This trend was not observed after adjusting for confounders. Winter season, age, and length of residence in the community were linked to decreased lung function.

Conclusions

Looking historically among residents within 1.5 miles of the IOF, living downwind of the oil field was associated with a higher likelihood of a baby being born preterm, particularly for those within half a mile, suggesting a possible impact of historical oil field operations on pregnancy outcomes. Living downwind of the IOF was associated with an increased odds of high blood pressure in our study of current residents. There was little association between blood pressure and residential proximity to the IOF. Among current residents, we found no evidence that residence near or downwind of the IOF was associated with health symptoms, self-reported chronic health conditions, or lung function. High cholesterol and cancer of all types were more commonly self-reported near the oil field, but these associations no longer remained after controlling for additional factors.

Strengths of our study include the relatively large sample size, multi-array of survey questions, personal measures of blood pressure and lung function (biometric analysis), inclusion of all live births (birth outcomes analysis), and precise information on residential location allowing us to accurately assess distance and wind direction from the oil field for both survey and historical birth outcome analysis. However, the cross-sectional nature of the survey and lack of personal measures of exposure to potential oil field related pollutants limits causal interpretations. Our study has several additional limitations that may have reduced our ability to detect adverse effects of the oil field. First, participants in the health survey and biometric measurement study were recruited through a combination of random sampling and convenience sampling, resulting in less representation of those with lower educational attainment and Hispanic/Latinx residents. This limits generalizability and reduces the likelihood of detecting potential associations with these possibly more vulnerable populations. Second, our reliance on self-reported health conditions that were not verified through medical records introduces potential inaccuracies of our estimates. In the birth outcomes analysis, a lack of information on miscarriages may have similarly led us to underestimate possible associations between historical oil field operations and pregnancy. Finally, as with all epidemiological studies, our findings may be subject to residual confounding due to factors such as lifestyle, genetic factors, or medication usage that were not measured and accounted for in our analysis.

Recommendations

- Further research should aim to incorporate longitudinal designs and larger sample sizes to confirm our results.
- 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 the 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), and in conjunction with the review of medical records and LA County cancer registry data.
- Future studies to measure contaminants in people’s bodies (biomonitoring) could help clarify whether people are being exposed to specific pollutants associated with oil drilling.

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1. Introduction

1.1 Short History of How Study Came About

The Inglewood Oil Field (IOF) in Los Angeles County (LAC) is the largest urban oil field in the nation and operates under the Baldwin Hills Community Standards District (CSD) adopted in October 2008. The CSD provides additional regulations for oil and gas production activities in the unincorporated portion of the IOF in Baldwin Hills including the communities of Ladera Heights and Baldwin Hills. The supplemental regulations were established to minimize the potential adverse impacts of operations on adjacent land uses, and to enhance the appearance of the site with property maintenance requirements, with the ultimate goal of protecting the comfort, health, safety, and welfare of the surrounding community.

Under the settlement agreement, reached in lawsuits between Community Health Councils v. County of Los Angeles challenging the Board of Supervisors' approval of the CSD in 2011, the LAC Department of Public Health ("Public Health") is required to complete a Health Assessment and Environmental Justice Study (Assessment) every five to seven years. The first assessment was completed in 2012. The overall objective of the Assessment is to evaluate nuisances, health, and environmental concerns of the community related to operations at the Inglewood Oil Field.

The Baldwin Hills **Steering Committee** ("Steering Committee") was developed to advise Public Health on the design of this second Assessment and develop the Work Order Solicitation described in Section 1.2. The Steering Committee was comprised of the following representatives:

(1) **CAP (Community Advisory Panel) Representatives:** Erica Blyther, Paul Ferrazzi, Liz Gosnell, Charles McCaw, Melanie Doran Traxler.
(2) **Expert Consultants:** Debra Bright Stevens (Environmental Audit, Inc.), Jill Johnston (USC), Seth Shonkoff (PSE Healthy Energy).
(3) **Public Health and Other Agencies:** Carrie Tayour and Christine De Rosa (Public Health); JoKay Ghosh, Nico Schulte (South Coast Air Quality Monitoring District (SCAQMD)).
(4) **Non-Committee Observers:** Tim Stapleton (LAC Regional Planning), B&McD and Intrinsik Staff; Carolyn Lozo, Kathleen Kozawa, Jonathan Blufer (California Air Resources Board (CARB)).

1.2 Work Order Solicitation and Overarching Project Objectives

The Baldwin Hills Health Assessment and Environmental Justice project focused on evaluating the health and environmental impacts associated with the IOF in LAC. Key objectives of this project included assessing health outcomes for nearby communities, understanding environmental justice concerns, and engaging local stakeholders to ensure the project was appropriately tailored to the community. The findings from this assessment will help inform local policies and health interventions to address environmental justice concerns in the Baldwin Hills area. The overall objective of the Assessment for evaluating nuisances, health, and environmental concerns of the community related to operations at the IOF was achieved through three specific objectives:

Objective 1: convene a Community Advisory Board (CAB) to inform the implementation of the assessment and facilitate two-way conversation between the Contractor and the community.

Objective 2: conduct a secondary data analysis of birth outcomes to women within a two-mile radius of the Inglewood Oil Field fence line to understand the impact of estimated exposure to oil field pollutants on birth outcomes.

Objective 3: conduct a household survey including a biometric measure and analyze collected data to understand the impact of oil field pollutants on short- and long-term health outcomes among residents living within a two-mile radius of the Inglewood oil field fence line.

Public Health funded and oversaw the execution of the project and provided input to strengthen the development and implementation of the Assessment and the interpretation of the findings.

1.3 Role of the Community Health Assessment Advisory Panel

The Community Health Assessment Advisory Panel (CHAAP) established to fulfill Objective 1 played a crucial role as the community advisory board for the Baldwin Hills Health Assessment and Environmental Justice Study. The primary purpose of the CHAAP was to provide input on study design, materials, and methods. CHAAP members were encouraged to provide feedback from their own experience and point of view, and as a representative of their community and organization, for the UCLA team to consider. CHAAP members, who were familiar with the IOF and community health concerns in surrounding areas, provided valuable expertise that enhanced the study methods and the validity of the information gathered by the UCLA team. They reviewed documents and listened to plans associated with the study, evaluating their potential effectiveness based on their knowledge and lived experience in the community. They offered feedback to improve the likelihood that these documents and plans would achieve their aims and address community concerns. CHAAP members also assisted with outreach for potential study participants by sharing the study's information with interested community members and communicating input from the broader community on study materials and methods.

CHAAP members met with the UCLA team as a group roughly once a month, usually on the last Thursdays of each month from 4:30 PM – 6:00 PM. Members received the meeting materials at the beginning of the meeting week. This regular meeting schedule ensured that all members were kept up-to-date with the progress of the study and had the opportunity to provide their input. The suggestions of the CHAAP members were recorded in meeting minutes and carefully considered by the UCLA research team in order to improve the study design, recruitment, and interpretability of the findings (See Attachments 1, 2, 3, and 4 in the Appendix for the CHAAP Feedback Tables of 2021-22, 2022-2023, 2023-2024, and 2024-2025, respectively).

2. Birth Outcome Analysis

2.1 Introduction

Los Angeles County, California, is located in one of the most historically productive oil basins in the world, with tens of thousands of extraction wells spread across multiple fields. Today, it produces almost 14 million barrels of oil annually[1], and half a million residents live within half a mile of an active well[2]. Oil and gas extraction can release contaminants into the environment, with documented cases of elevated concentration of pollutants in air, water, and soil near oil production sites[3]. In Los Angeles, prior studies have focused on the Las Cienegas oil field and found elevated concentrations of methane and non-methane hydrocarbons in the air[4] and higher exposures to manganese and nickel in residents living near oil and gas operations[5].

Over a dozen epidemiological studies have examined the relationship between oil and gas production and pregnancy outcomes. The majority of these studies found that living near oil and gas production is associated with an increased risk of preterm birth (prior to 37 completed weeks gestation) or reduced fetal growth[6]. However, the evidence regarding residential proximity to oil production and preterm birth in California is mixed[7,8], and only two related prior analyses have assessed measures of fetal growth[8,9]. No peer-reviewed studies focused exclusively in Los Angeles have assessed pregnancy outcomes surrounding oil operations.

We utilized twenty years of administrative health records to test the hypothesis that residence near the Inglewood Oil Field (IOF) was associated with higher risks of adverse birth outcomes. The IOF is the largest contiguous urban oil field in the U.S., encompassing roughly 1,000 acres and hundreds of oil wells within a densely populated urban area. We focused on births occurring within 1.5 miles of the IOF and looked for differences in birth outcomes with distance, wind direction, time relative to the initiation of stricter regulation of oil field operations in 2008, and metrics of oil and gas production intensity. We assessed four outcomes related to length of gestation (preterm birth and gestational age) and fetal growth (small-for-gestational age and birthweight for gestational age z-scores). Preterm birth is a primary predictor of infant mortality and can be associated with lifelong health problems, while reductions in fetal growth have been associated with increased chronic disease risk in adulthood.

2.2 Methods

We conducted a retrospective cohort study of singleton births within 1.5 miles of the IOF between 2000 and 2019. Residential address at the time of birth was used to assign proxy measures of exposure to the IOF relating to distance, wind direction, and oil and gas operations. We used multivariable regression models to examine associations with preterm birth, small-for-gestational age, gestational age, and birthweight while controlling for individual-level biological and socioeconomic variables and neighborhood-level poverty, green space and traffic. Study protocols were approved by the Institutional Review Boards of the University of California, Los Angeles (21-001613) and Los Angeles County Department of Public Health (#7127).

Study Population

Administrative birth records for the County of Los Angeles were obtained from the California Department of Public Health (CDPH) for the years 2000-2019. Addresses for the 2019 births were geocoded into a latitude and longitude by CDPH. We geo-coded addresses from prior years using ArcGIS software (ESRI, Redlands, CA). Births were eligible for inclusion if they were singletons (we excluded twins, triplets, etc.) and without congenital birth anomalies. We additionally excluded births that could not be geo-coded, for which no valid estimate of gestational age was available, those with gestational age < 20 completed weeks or > 42 weeks which were deemed improbable, and births with an improbable combination of gestational age and birthweight using cut points from a national reference corresponding to the mean ± 2 standard deviation (SD) birthweight by gestational age week[10]. This reference only included gestational ages of 22 weeks and greater. We therefore excluded 20- or 21-week births with birthweights greater than the mean + 2 SD of 22-week babies.

Birth Outcomes

We assessed four outcomes: preterm birth (PTB, <37 completed weeks, binary variable), small for gestational age (SGA, birth weight less than the U.S. sex-specific 10th percentile of weight for each week of gestation, binary variable), gestational age (weeks, continuous variable), and birthweight z-scores (BW-Z, continuous variable). PTB was further characterized as extreme (20-28 weeks), early preterm (29-32), and moderate preterm (33-36 weeks). Gestational age in days was estimated using the obstetrician's best estimate of completed weeks gestation plus a random number from 0-6 for the day of the week. If an obstetrician's estimate was not available, gestational age was calculated by subtracting the last menstrual period date from the date of birth. We utilized a 2009-2010 U.S. reference population to calculate SGA and BW-Z[10].

Exposure Metrics

The birth parent's residential address at the time of the birth was used to construct both static and time-varying proxy measures of exposure to oilfield operations. Static measures included wind direction (downwind vs. upwind of the IOF, binary variable), minimum distance to the oil field property boundary (miles, categorized into ≤0.5, >0.5 to ≤1.0, and >1.0 to ≤1.5 distance bands in the primary analysis), and time of birth relative to the adoption of the Community Standards District (CSD) which brought about more stringent regulations of oil field operations. The IOF property boundary was obtained from

MRS Environmental and used to calculate the Euclidean (as-the-crow files) distance between the birth parent's residential address and the oil field in R (**Figure 1**). Prevailing wind direction at the IOF meteorological station was from the Southwest (240°, with 0° being North) (**Figure 2**). We defined downwind vs. upwind on the basis of 180° increments, with downwind being ≥330° to <150° and upwind being ≥151° to <330°. The Los Angeles County Board of Supervisors adopted the Community Standards District (CSD) increasing regulation of activities at the IOF on October 28, 2008. We considered the "post-CSD" time period starting January 1, 2009 as a possible indicator of improving environmental conditions surrounding the IOF.

We additionally constructed several time-varying measures related to oil and gas operations, including the sum of active and inactive oil and gas wells within 0.5 miles (count); the total oil and gas produced within 0.5 miles during pregnancy (mean barrels of oil equivalent per day, BOE/day); the estimated number of drill rigs operating on-site during pregnancy (rigs); and the total mass of air toxics applied in oil field operations during pregnancy (lbs.).

To construct these metrics, we downloaded the location of every oil and gas well permit on January 29, 2023 from the California Geologic Energy Management Division (CalGEM) of the California Department of Conservation. We filtered the dataset to include only wells located within the IOF using the "FieldName" variable and only wells described as type "Oil & Gas". Active versus inactive well status was defined using monthly production data from CalGEM (described below). A well was defined as active if the operator reported producing more than 1 unit of gas or oil in at least one of the months overlapping with a pregnancy (between conception and birth date). If no oil or gas production was reported from a well during this time frame, it was considered inactive. Thus, the same well could be considered active relative to one pregnancy but inactive relative to another.

Monthly oil and gas production data for years 1999 to 2019 were downloaded from the CalGEM database. For 1999 to 2017, we joined production data for IOF wells based on the 9-digit API number. For 2018-2020, the production data included an 11-digit API number; we therefore summed the oil and gas produced for all sub-units with the same 9-digit API and then dropped the 2-digit sub-units from each well before we linked production data with the permit data. We calculated the total barrels of equivalent (BOE) by summing the "OilorCondensateProduced" and "GasProduced(MCF)"/6 between the conception and birth date separately for wells located within the 0.5, 1.0, and 1.5 mile distance from the birth parent's residential address as has been done in prior studies[10]. Monthly production volume was weighted according to overlap with the days of pregnancy (e.g., if the pregnancy start date was Feb 15th, only half of February's production volume was counted).

Annual information on the total number of operating drill rigs was extracted from a Health Risk Assessment conducted by MRS Environmental and available for years 2010-2019. Based on the degree of overlap between each pregnancy and each calendar year, we generated a weighted sum of drill rigs for each pregnancy. The number of operating drill rigs prior to 2010 was not available, so births occurring prior to 2010 could not be assigned an estimate.

Under South Coast Air Quality Management District (SCAQMD) Rule 1148.2, oil operators and chemical suppliers in select portions of the state are required to report their use of chemicals for well stimulation (hydraulic fracturing, matrix acidizing) and routine activities such as well drilling, well completion, and well rework. The rule went into effect on June 4, 2013. We downloaded chemical use data through 2019 from the SCAQMD website. We excluded chemical usage reported prior to September 2015 because the dates of usage were not included for those records. Data included zip code, well location (latitude, longitude), API number, activity start and end date, purpose, and the mass of chemicals utilized (pounds) by chemical name and CAS number. A subset of chemicals was identified in the dataset as air toxics. We summed the pounds of total chemicals (excluding water) and air toxics applied by month for zip code 90056, the only overlapping or adjacent zip code to the IOF for which any chemical usage was reported. These were then assigned to births based on a weighted sum of the months overlapping with the pregnancy. Months prior to September 2015 were coded as missing, whereas months after were coded as zero if there was no chemical usage reported.

Covariates

Individual-level covariates that were identified *a priori* as predictors of our outcomes and potential confounders or precision variables based on prior studies were derived from the birth records. Infant covariates include sex, and month and year of birth to control for seasonal and secular trends. Covariates related to the birth parent included age in years (<20, 20-24, 25-29, 30-34, 35+), parity (the total number of births), nativity (foreign- vs. US-born), race/ethnicity (Hispanic/Latinx, and non-Hispanic White, Black, Asian-Pacific Islander, and other/unknown/multiracial), educational attainment (<high school, high school graduate/GED, some college, college+), insurance status based on primary source of expected payment (private vs. public or uninsured/unknown) and prenatal care (inadequate, intermediate, adequate, or adequate plus). Prenatal care was characterized using an index combining the week prenatal care was initiated as well as the number of visits[11]. Information on smoking was missing for births prior to 2007, and relatively rare thereafter (<1% of births). Pre-pregnancy body mass index (BMI) was also not available prior to 2007. Therefore, smoking and BMI were not included.

We utilized 2010 census geography to estimate potential neighborhood-level confounders. Census-tract level normalized difference vegetation index (NDVI) was calculated using 2020 satellite imagery from the USGS National Agriculture Imagery Program as described elsewhere[12]. NDVI is an index of the degree of vegetative greenness (i.e., green space) that has been linked to better birth outcomes in prior studies[13]. We utilized a census-tract level indicator of traffic density from CalEnviroScreen 4.0 to control for traffic-related pollution[14]. In brief, this indicator is the sum of all road length-adjusted traffic volumes per hour, divided by the total road length in and within 150 meters of each tract boundary. The census block group level percent of households living below twice the federal poverty line was obtained from the American Community Survey using the 2008-12 5-year estimate (midpoint of the study period).

Statistical Analysis

We examined descriptive statistics and correlation coefficients between all variables of interest to inform model specification and assess whether particular covariates might need to be excluded from our models due to multi-collinearity. Associations between oil-field related exposure metrics and our outcomes were then estimated via a series of regression models. Logistic models were used for the binary outcome variables of preterm birth and SGA. Linear models were used for the continuous measures of gestational age and birthweight z-score. Each model included one primary exposure metric and controlled for the covariates described above. Stratified models were used to determine whether associations varied with distance to the IOF boundary, race/ethnicity or education of the birth parent. Population Attributable Fraction (PAF) was calculated using `PAF_calc_discrete` function from the `graphPAF` package. This function estimated the PAF for the binary risk factor of wind direction based on the logistic regression model, which was previously defined.

2.3 Results

Study Population

The final study population included 35,221 births (**Figure 3**). The overall rate of preterm and small-for-gestational age births were higher in the study population (7.9% and 9.0%, **Table 1**) than they were in Los Angeles County overall over the same time period and when applying the same exclusion criteria (7.5% and 8.1%, $P < 0.05$, two proportion Z test). The average age, educational attainment, and the proportion of Black, White, privately insured, and US-born birth parents were higher among those closer to the oil field (**Table 1**). The rate of preterm and small-for-gestational age births were highest within 0.5-1.0 miles of the IOF, and lowest within 0.5 miles of the field (**Table 1**).

Roughly half (53.1%) of births occurred downwind of the oil field and the majority (66%) occurred more than a mile from the IOF. On average (based on non-zero records), there were 11 active wells, 3 inactive wells, and 150 BOE produced per day within 0.5 miles of births in the study population (**Table 2**). On average, 10 drill rigs were active and 60,000 pounds of air toxics and 89,000 pounds of total chemicals were applied within 1.5 miles over the roughly 9-month time period of each pregnancy. In subsequent regression models, these variables were dichotomized into high vs. low/none based roughly on the median value observed.

Unadjusted Associations

Within all three distance bands (0.5, 0.5-1.0, and 1.0-1.5 miles), crude rates of preterm birth were higher and mean gestational age was lower downwind than upwind of the oil field (**Table 3**). Differences in crude rates of SGA and mean birthweight between downwind and upwind populations were not statistically significant (**Table 3).** Among all births, a high number of active wells, inactive wells, and production volume within 1.5 miles were associated with a slightly higher crude rates of preterm and SGA, relative to low or no wells or production, but none of the differences were statistically significant (**Table 4**).

Regression Models

In logistic regression models adjusting for sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate, we estimated that the odds of preterm birth were 22% higher downwind of the oil field relative to upwind overall (adjusted odds ratio (OR) [95% confidence interval] = 1.22 [1.06, 1.41] (**Figure 4a**). The association was strongest among births closest to the oil field (within 0.5 miles), where the odds of preterm birth were 56% higher downwind of the oil field relative to upwind (OR = 1.56 [1.08, 2.27]) (**Figure 4a**). The odds of preterm birth were lower after the implementation of the CSD in the overall population (OR [95% CI] = 0.67 [0.55, 0.81]), with no strong difference in the association based on proximity to the oil field (**Figure 4b**). A high level of oil and gas activity during pregnancy was not associated with the odds of preterm birth (**Figure 4c**). We saw no statistically significant associations between wind direction, CSD implementation date, and oil and gas production and the odds of SGA (**Figure 5**).

In adjusted linear regression models of gestational age as a continuous variable, we saw the mean GA was lower downwind as compared to upwind of the oil field overall and for those who live within 0.5 mile of the oil field boundary (mean difference [95% CI] in weeks = -0.10 [-0.16, -0.03] and -0.23 [-0.40, -0.05], respectively) (**Figure 6a**). The mean GA was higher post-CSD compared to pre-CSD in the total study population (mean difference [95% CI] = 0.14 [0.05, 0.23 (**Figure 6b**). None of the associations between GA and our measures of OG activity were statistically significant (**Figure 6c**).

In adjusted linear regression models, no strong associations were observed between BW-Z and wind direction relative to the IOF **(Figure 7a**). The CSD was associated with higher mean BW-Z among births 1.0-1.5 miles from the IOF (mean difference [95% CI] in grams = 0.05 [0.01, 0.10]) (**Figure 7b**). A high number of active and inactive wells were associated with lower BW-Z scores, but none of the differences were statistically significant **(Figure 7c).**

Effect estimates for covariates in these models were in the expected direction (**Tables 5-8**). The number of drill rigs and quantity of air toxics and total chemicals applied on the oil field were not strongly associated with any of our outcomes, in unadjusted analyses (**Table 9)** or adjusted analyses controlling for sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate (**Figures 8a and 8b**).

In a sensitivity analysis where we looked at distance to the oil field boundary as a continuous variable, distance was not strongly associated with any of the four outcomes when controlling for wind direction (downwind vs. upwind), sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate (**Table 10**).

Population Attributable Fraction

Assuming the association between living downwind of the Industrial Oil Facility (IOF) and preterm births (PTBs) is causal, approximately **10.7%** of preterm births in the 1.5-mile study population could have been prevented if none of the residents lived within this downwind zone over the last 20 years. This equated to roughly **175 cases** of preterm birth across the study population living within 1.5 miles of the IOF.

2.4 Discussion

In this retrospective analysis of 20 years of births occurring within 1.5 miles of the IOF, we found that living downwind and within 0.5 miles of the oilfield was associated with a higher likelihood of preterm birth. Our findings were consistent when we looked at gestational age as a continuous outcome, with decreases in mean gestational age downwind of the oilfield, especially with closer proximity to the IOF. If these associations are causal, we estimated that the removal of the IOF would have resulted in 175 cases of preterm birth being prevented over a 20-year period. We also observed evidence that the likelihood of preterm birth was lower after more stringent regulation of oil field operations were put in place with the CSD adopted in October 2008. However, our analysis does not provide sufficient evidence to suggest changes in regulation caused reductions in the likelihood of preterm birth because we saw no variation in our effect estimates with distance to the oil field and a similar decline in preterm birth rates was seen across Los Angeles County as a whole over the study time period. We found no association between the intensity of oil and gas operations within 0.5 miles and the odds of preterm birth. A high number of active wells and oil were associated with a slight decrease in average gestational age, but confidence intervals for these associations were wide and crossed the null, so that we could not rule out that these associations were due to chance.

Our findings regarding preterm birth were consistent with prior studies reporting an association between oil and gas development and preterm birth in Pennsylvania[21], Texas[15,16,17], and California[7]. The prior California study was conducted in the San Joaquin Valley found that living within 10 km of a high density of active oil and gas wells was associated with an elevated likelihood of very preterm births (between 28-31 weeks)[7]. In contrast, a statewide analysis from California found little evidence of increased risks of preterm birth associated with living within 1km of oil production or inactive wells[8].

We found less evidence of an influence of the oil field on fetal growth. We found no associations between residential proximity to the oil field, living downwind, or the intensity of oil operations during pregnancy and the likelihood of SGA. Birthweight z-scores were higher on average following the implementation of the CSD, but this association was not apparent within the population living closest to the oil field (<0.5 miles). Our measures of intensity of oil operations were also not associated with SGA or average birthweight z-scores in adjusted analyses. Prior studies in Pennsylvania[18,19], Texas[17], California[8,9], and Alberta, Canada[20] have found evidence of reduced fetal growth near oil and gas development, but in general the findings of prior oil and gas studies were less consistent with respect to fetal growth measures than they were with respect to preterm birth[6]. The statewide analysis of California births found an increased odds of low birth weight and SGA births among people living within 1km of active oil and gas wells producing over 100 barrels of oil equivalent per day[8] or hydraulic fracturing[9], particularly among rural communities.

A strength of this study was the inclusion of 20 years of administrative birth records, capturing virtually all births in the area and resulting in a large sample size of over 35,000 births with strong underlying statistical power. Data were unavailable to characterize exposure to pollutants resulting from oil field operation, and a limitation of our study and many others that have examined similar hypotheses in other communities is that we relied on proxy measures of exposure based on distance, wind direction, and permit and production data. The birth records did not include residential histories, so we may have included some babies born to parents that moved into the study area prior to birth but lived elsewhere earlier in their pregnancy. Finally, although we were able to control many known individual- and neighborhood- level predictors of adverse birth outcomes, as with any epidemiological study it is possible that our results were biased by unmeasured or residual confounding.

Table 1: Characteristics of the study population of births within 1.5 miles of the IOF, 2000-2019 (N=35,221), stratified by residential distance to the oil field property boundary. HS = high school, SD = standard deviation.

	Overall (N=35,221)	0 – 0.5 miles (N=3096)	0.5 – 1.0 miles (N=8919)	1.0 – 1.5 miles (N=23206)	P-value[1]
Preterm birth, N (%)	2800 (7.9%)	241 (7.8%)	731 (8.2%)	1828 (7.9%)	0.60
Moderate (33-36 weeks), N (%)	2370 (6.7%)	212 (6.8%)	610 (6.8%)	1548 (6.7%)	0.59
Early (29-32 weeks), N (%)	260 (0.7%)	15 (0.5%)	73 (0.8%)	172 (0.7%)	
Extreme (20-28 weeks), N (%)	170 (0.5%)	14 (0.5%)	48 (0.5%)	108 (0.5%)	
Small-for-gestational age, N (%)	3157 (9.0 %)	252 (8.1%)	860 (9.6%)	2045 (8.8%)	0.02
Gestational age (weeks), mean (SD)	38.8 (2.0)	38.8 (2.0)	38.7 (2.0)	38.8 (2.0)	0.08
Birthweight Z-score, mean (SD)	-0.06 (0.86)	-0.04 (0.85)	-0.07 (0.87)	-0.06 (0.86)	0.25
Age (years), mean (SD)	29.6 (6.3)	32.7 (5.6)	30.1 (6.4)	29.0 (6.2)	<0.001
Education					
Completed college or higher	11976 (34.0%)	1961 (63.3%)	3490 (39.1%)	6525 (28.1%)	<0.001
HS graduate / some college	15504 (44.0%)	957 (30.9%)	3763 (42.2%)	10784 (46.5%)	
Less than HS	6525 (18.5%)	82 (2.6%)	1411 (15.8%)	5032 (21.7%)	
Missing	1216 (3.5%)	96 (3.1%)	255 (2.9%)	865 (3.7%)	
Race / Ethnicity					
Black	8991 (25.5%)	913 (29.5%)	2572 (28.8 %)	5506 (23.7%)	<0.001
Hispanic	13821 (39.2%)	439 (14.2%)	2910 (32.6%)	10742 (45.1%)	
White	4719 (13.4%)	746 (24.1%)	1433 (16.1%)	2540 (10.9%)	
Asian/Pacific Islander	2809 (8.0%)	355 (11.5%)	664 (7.4%)	1790 (7.7%)	
Other	3802 (10.8%)	519 (16.8%)	1051 (11.8%)	2232 (9.6%)	
Missing	1079 (3.1%)	124 (4.0%)	289 (3.2%)	666 (2.9%)	
Insurance					
Private	19113 (54.3%)	2519 (81.4%)	5346 (59.9%)	11248 (48.5%)	<0.001
Public	15505 (44.0%)	489 (15.8%)	3414 (38.3%)	11602 (50.0%)	
Uninsured / Unknown	603 (1.7%)	88 (2.8%)	159 (1.8%)	356 (1.5%)	
Country of birth					
Outside US	4781 (13.6%)	373 (12.0%)	1153 (12.9%)	3255 (14.0%)	0.001
US born	30440 (86.4%)	2723 (88.0%)	7766 (87.1%)	19951 (86.0%)	
Prenatal care					
Inadequate	3471 (9.9%)	190 (6.1%)	878 (9.8%)	2403 (10.4%)	<0.001
Intermediate	10858 (30.8%)	893 (28.8%)	2671 (29.9%)	7294 (31.4%)	
Adequate	15441 (43.8%)	1441 (46.5%)	3892 (43.6%)	10108 (43.6%)	
Adequate plus	3285 (9.3%)	376 (12.1%)	921 (10.3%)	1988 (8.6%)	

	Missing	2166 (6.1%)	196 (6.3%)	557 (6.2%)	1413 (6.1%)	
Smoking						
	Yes	90 (0.3%)	8 (0.3%)	24 (0.3%)	58 (0.3%)	0.972
	No	22896 (65.0%)	2061 (66.6%)	5853 (65.6%)	14982 (64.6%)	
	Missing	12235 (34.7%)	1027 (33.2%)	3042 (34.1%)	8166 (35.2%)	

[1] P-values are from analysis of variance (ANOVA) (for continuous variables) and chi-square test (for categorical variables) and test the null hypothesis of no difference across groups based on distance to the oil field.

Table 2: Summary of exposure metrics and neighborhood covariates, 2000-2019 births within 1.5 miles of the IOF (n= 35,221). BOE = barrels of oil equivalent

	Minimum	Median (25th, 75th percentile)	Maximum	N (%) missing
Non-zero Active wells within 0.5 miles (count) [1]	1	11 (3, 35)	142	0 (0%)
Non-zero Inactive wells within 0.5 miles (count) [1]	1	3 (2, 26)	318	0 (0%)
Non-zero Production volume within 0.5 miles (BOE/day) [1]	0.004	150 (38,577)	2786	0 (0%)
Weighted average number of drill rigs (count) [1]	0	10.5 (0, 18.5)	33.3	20,705[2] (52.0%)
Sum of air toxics applied (lbs.) [1]	0	64,854.8 (11072.4, 113020.4)	22,1731.7	25,925 (77.7%)[3]
Sum of total chemicals applied (lbs.) [1]	0	89,118.6 (15100.8, 158049.0)	25,3270.0	25,925 (77.7%)[3]
Green Space	-0.097	0.027 (-0.016, 0.074)	0.190	0 (0%)
Traffic	505.1	1,254.9 (843.7, 2,441.4)	5114.9	0 (0%)
Neighborhood poverty rate (%)	0	0.39 (0.23, 0.57)	0.79	0 (0%)

[1] Time-varying measures defined based on the time frame of the pregnancy. This means the same well may be categorized as “active” for one pregnancy but “inactive” for another.

[2] Data on the number of drill rigs were not available prior to 2010 such that estimates of exposure could not be assigned for roughly half of births.

[3] Data on air toxics and chemicals applied were not available prior to September 2015 such that estimates of exposure could not be assigned for roughly three quarters of births.

Table 3: Birth outcomes by residential distance to the IOF boundary and wind direction (N=35,221). BW-Z= birthweight z-score, SD = standard deviation, SGA = small for gestational age

	0 – 0.5 miles (N=3,096)		**0.5 – 1.0 miles** (N=8,919)		**1.0 – 1.5 miles** (N=23,206)	
	Upwind	Downwind	Upwind	Downwind	Upwind	Downwind
Preterm birth, N (%)	118 (6.4%)	123 (9.8%)**	267 (7.2%)	464 (8.9%)**	781 (7.1%)	1047 (8.5%)**
SGA, N (%)	156 (8.5%)	96 (7.6%)	334 (9.0%)	526 (10.1%)	960 (8.8%)	1085 (8.9%)
Gestational age (weeks), mean (SD)	39.0 (1.76)	38.6 (2.22)**	38.9 (1.89)	38.6 (2.10)**	38.8 (1.90)	38.7 (2.05)**
BW-Z (grams), mean (SD)	-0.022 (0.852)	-0.074 (0.844)	-0.066 (0.847)	-0.077 (0.880)	-0.063 (0.855)	-0.058 (0.862)

* P-value < 0.05, two-proportional z test for counts/proportions, and two-sample t test for continuous variables
** P-value <0.01, two-proportional z test for counts/proportions, and two-sample t test for continuous variables

Table 4: Birth outcomes by high vs. low oil and gas-related activity within 0.5 miles (N=35,221) of residence across all births within 1.5 miles of the oil field. BOE = barrels of oil equivalent, BW-Z= birthweight z-score, SD = standard deviation =, SGA = small for gestational age

	Active wells		**Inactive wells**		**Production**	
	Low (0-11) N=34,168	High (>11) N=1053	Low (0-3) N=32,359	High (>3) N=2,862	Low (0-150 BOE) N=34,163	High (>150 BOE) N=1,058
Preterm birth, N (%)	2714 (7.9%)	86 (8.2%)	2591 (8.0%)	209 (7.3%)	2712 (7.9%)	88 (8.3%)
SGA, N (%)	3064 (9.0%)	93 (8.8%)	2928 (9.0%)	229 (8.0%)	3061 (9.0%)	96 (9.1%)
Gestational age (weeks), mean (SD)	39 (2.0)	39 (2.0)	39 (2.0)	39 (1.9)*	39 (2.0)	39 (2.0)
BW-Z (grams), mean (SD)	-0.065 (0.86)	-0.043 (0.86)	-0.066 (0.86)	-0.041 (0.85)	-0.065 (0.86)	-0.041 (0.87)

* P-value < 0.05, two-proportional z test for counts/proportions, and two-sample t test for continuous variables
** P-value <0.01, two-proportional z test for counts/proportions, and two-sample t test for continuous variable

Table 5: Preterm birth odds ratios and 95% confidence intervals from logistic regression models. BOE = barrels of oil equivalent, CSD = Community Standards District

	Downwind (ref: upwind)	Post-CSD (ref: pre-CSD)	High active well count (ref: low)	High inactive well count (ref: low)	High BOE (ref: low)
Exposed (vs. not)	1.22 [1.06, 1.41]	0.81 [0.67, 0.99]	0.98 [0.76, 1.28]	0.96 [0.81, 1.14]	1.01 [0.78, 1.31]
Age (vs.20-24 years)					
25-29 years	1.02 [0.88, 1.18]	1.01 [0.87, 1.17]	1.01 [0.87, 1.17]	1.01 [0.87, 1.17]	1.01 [0.87, 1.17]
30-34 years	1.20 [1.04, 1.40]	1.20 [1.03, 1.39]	1.2 [1.03, 1.39]	1.2 [1.03, 1.39]	1.2 [1.03, 1.39]
34 years or older	1.67 [1.44, 1.95]	1.65 [1.41, 1.92]	1.65 [1.41, 1.93]	1.65 [1.42, 1.93]	1.65 [1.41, 1.93]
20 years or younger	1.08 [0.90, 1.29]	1.08 [0.90, 1.29]	1.07 [0.9, 1.29]	1.07 [0.9, 1.29]	1.07 [0.9, 1.29]
Female (vs. male)	0.81 [0.74, 0.88]	0.79 [0.73, 0.86]	0.79 [0.73, 0.86]	0.79 [0.73, 0.86]	0.79 [0.73, 0.86]
Education (vs. college or higher)					
HS graduate / some college	1.37 [1.21, 1.55]	1.40 [1.24, 1.59]	1.4 [1.24, 1.58]	1.4 [1.24, 1.58]	1.4 [1.24, 1.58]
Less than HS	1.30 [1.09, 1.54]	1.27 [1.07, 1.51]	1.27 [1.07, 1.51]	1.27 [1.07, 1.51]	1.27 [1.07, 1.51]
Insurance (vs. Private)					
Public	1.09 [0.98, 1.21]	1.08 [0.97, 1.20]	1.08 [0.97, 1.21]	1.08 [0.97, 1.21]	1.08 [0.97, 1.21]
Unknown	1.19 [0.86, 1.65]	1.18 [0.85, 1.63]	1.18 [0.86, 1.63]	1.18 [0.86, 1.63]	1.18 [0.86, 1.63]
US born (vs. not)	1.15 [1.01, 1.32]	1.05 [0.91, 1.22]	1.13 [0.99, 1.29]	1.13 [0.99, 1.29]	1.13 [0.99, 1.29]
Parity (vs. first born)	0.94 [0.85, 1.04]	0.92 [0.84, 1.01]	0.92 [0.84, 1.01]	0.92 [0.84, 1.01]	0.92 [0.84, 1.01]
Race / Ethnicity (vs. Asian Pacific)					
Black	1.10 [0.91, 1.32]	1.10 [0.91, 1.32]	1.1 [0.91, 1.32]	1.1 [0.91, 1.32]	1.1 [0.91, 1.32]
Hispanic	0.93 [0.77, 1.12]	0.92 [0.77, 1.11]	0.93 [0.78, 1.13]	0.93 [0.78, 1.13]	0.93 [0.78, 1.13]
White	0.75 [0.61, 0.92]	0.73 [0.60, 0.90]	0.73 [0.6, 0.9]	0.74 [0.6, 0.9]	0.73 [0.6, 0.9]
Other	1.06 [0.85, 1.31]	1.05 [0.85, 1.30]	1.09 [0.88, 1.34]	1.09 [0.88, 1.34]	1.09 [0.88, 1.34]
Year of birth	0.98 [0.97, 0.99]	1.00 [0.98, 1.01]	0.98 [0.97, 0.99]	0.98 [0.97, 0.99]	0.98 [0.97, 0.99]
Season of birth (vs. Fall)					
Spring	1.06 [0.94, 1.20]	1.05 [0.93, 1.19]	1.05 [0.93, 1.19]	1.05 [0.93, 1.19]	1.05 [0.93, 1.19]
Summer	1.06 [0.94, 1.20]	1.06 [0.94, 1.19]	1.06 [0.94, 1.19]	1.06 [0.94, 1.19]	1.06 [0.94, 1.19]
Winter	1.07 [0.95, 1.21]	1.05 [0.93, 1.19]	1.05 [0.93, 1.19]	1.05 [0.93, 1.19]	1.05 [0.93, 1.19]
Prenatal care (vs. Adequate)					
Inadequate	0.81 [0.58, 1.14]	0.84 [0.60, 1.18]	0.85 [0.6, 1.19]	0.84 [0.6, 1.19]	0.85 [0.6, 1.19]
Intermediate	0.54 [0.38, 0.76]	0.54 [0.38, 0.78]	0.55 [0.38, 0.78]	0.55 [0.38, 0.78]	0.55 [0.38, 0.78]
Adequate plus	1.44 [0.76, 2.74]	1.50 [0.79, 2.84]	1.5 [0.79, 2.85]	1.5 [0.79, 2.85]	1.5 [0.79, 2.85]

Green Space	0.59 [0.22, 1.55]	1.26 [0.57, 2.77]	1.28 [0.58, 2.83]	1.29 [0.59, 2.85]	1.26 [0.57, 2.79]
Traffic	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]	1 [1, 1]	1 [1, 1]	1 [1, 1]
Ratio of Income to Poverty Line	0.82 [0.63, 1.06]	0.96 [0.76, 1.22]	0.96 [0.76, 1.22]	0.95 [0.75, 1.21]	0.97 [0.76, 1.23]

Table 6: Small-for-gestational age odds ratios and 95% confidence intervals from logistic regression models. BOE = barrels of oil equivalent, CSD = Community Standards District

	Downwind (ref: upwind)	Post-CSD (ref: pre-CSD)	High active well count (ref: low)	High inactive well count (ref: low)	High BOE (ref: low)
Exposed (vs. not)	0.98 [0.86, 1.11]	0.99 [0.82, 1.18]	1 [0.78, 1.28]	0.94 [0.8, 1.1]	1.02 [0.8, 1.3]
Age (vs.20-24 years)					
25-29 years	0.95 [0.83, 1.08]	0.95 [0.83, 1.08]	0.95 [0.83, 1.08]	0.95 [0.83, 1.08]	0.95 [0.83, 1.08]
30-34 years	0.95 [0.83, 1.09]	0.95 [0.83, 1.09]	0.95 [0.83, 1.09]	0.95 [0.83, 1.09]	0.95 [0.83, 1.09]
34 years or older	1.01 [0.88, 1.17]	1.01 [0.88, 1.17]	1.01 [0.88, 1.17]	1.01 [0.88, 1.17]	1.01 [0.88, 1.17]
20 years or younger	1.12 [0.96, 1.31]	1.12 [0.96, 1.31]	1.12 [0.96, 1.31]	1.12 [0.96, 1.31]	1.12 [0.96, 1.31]
Female (vs. male)	0.96 [0.89, 1.04]	0.96 [0.89, 1.04]	0.96 [0.89, 1.04]	0.96 [0.89, 1.04]	0.96 [0.89, 1.04]
Education (vs. college or higher)					
HS graduate / some college	1.11 [0.99, 1.24]	1.11 [0.99, 1.24]	1.11 [0.99, 1.24]	1.11 [0.99, 1.24]	1.11 [0.99, 1.24]
Less than HS	1.19 [1.02, 1.40]	1.19 [1.02, 1.40]	1.19 [1.02, 1.4]	1.19 [1.01, 1.39]	1.19 [1.02, 1.4]
Insurance (vs. Private)					
Public	1.12 [1.01, 1.24]	1.12 [1.01, 1.24]	1.12 [1.01, 1.24]	1.12 [1.01, 1.23]	1.12 [1.01, 1.24]
Unknown	1.20 [0.90, 1.61]	1.20 [0.90, 1.61]	1.2 [0.9, 1.61]	1.2 [0.9, 1.61]	1.2 [0.9, 1.61]
US born (vs. not)	1.03 [0.92, 1.16]	1.02 [0.90, 1.17]	1.03 [0.92, 1.16]	1.03 [0.92, 1.16]	1.03 [0.92, 1.16]
Parity (vs. first born)	0.63 [0.57, 0.68]	0.63 [0.57, 0.68]	0.63 [0.57, 0.68]	0.63 [0.57, 0.68]	0.63 [0.57, 0.68]
Race / Ethnicity (vs. Asian Pacific)					
Black	0.94 [0.81, 1.10]	0.94 [0.81, 1.10]	0.94 [0.81, 1.1]	0.94 [0.81, 1.1]	0.94 [0.81, 1.1]
Hispanic	0.60 [0.51, 0.71]	0.60 [0.51, 0.70]	0.6 [0.51, 0.7]	0.6 [0.51, 0.7]	0.6 [0.51, 0.7]
White	0.56 [0.47, 0.67]	0.56 [0.47, 0.67]	0.56 [0.47, 0.67]	0.56 [0.47, 0.67]	0.56 [0.47, 0.67]
Other	0.71 [0.59, 0.85]	0.70 [0.58, 0.85]	0.71 [0.59, 0.85]	0.71 [0.59, 0.85]	0.71 [0.59, 0.85]
Year of birth	1.01 [1.00, 1.01]	1.01 [0.99, 1.02]	1.01 [1, 1.01]	1.01 [1, 1.01]	1.01 [1, 1.01]
Season of birth (vs. Fall)					
Spring	0.88 [0.79, 0.98]	0.88 [0.79, 0.98]	0.88 [0.79, 0.98]	0.88 [0.79, 0.98]	0.88 [0.79, 0.98]
Summer	0.84 [0.76, 0.94]	0.84 [0.76, 0.94]	0.84 [0.76, 0.94]	0.84 [0.76, 0.94]	0.84 [0.76, 0.94]
Winter	0.94 [0.84, 1.05]	0.94 [0.84, 1.05]	0.94 [0.84, 1.05]	0.94 [0.84, 1.05]	0.94 [0.84, 1.05]
Prenatal care (vs. Adequate)					
Inadequate	0.96 [0.69, 1.35]	0.96 [0.69, 1.35]	0.96 [0.69, 1.35]	0.96 [0.69, 1.35]	0.96 [0.69, 1.35]
Intermediate	0.92 [0.65, 1.30]	0.92 [0.65, 1.30]	0.92 [0.65, 1.3]	0.92 [0.65, 1.3]	0.92 [0.65, 1.3]
Adequate plus	1.66 [0.89, 3.11]	1.66 [0.89, 3.11]	1.66 [0.89, 3.11]	1.66 [0.89, 3.11]	1.66 [0.89, 3.11]

Green Space	0.74 [0.30, 1.82]	0.67 [0.33, 1.39]	0.67 [0.32, 1.41]	0.7 [0.34, 1.45]	0.67 [0.32, 1.39]
Traffic	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]	1 [1, 1]	1 [1, 1]	1 [1, 1]
Ratio of Income to Poverty Line	1.15 [0.90, 1.47]	1.13 [0.90, 1.41]	1.13 [0.9, 1.41]	1.1 [0.88, 1.39]	1.13 [0.9, 1.41]

Table 7: Mean difference in gestational age (in weeks) and 95% confidence intervals from linear regression models. BOE = barrels of oil equivalent, CSD = Community Standards District

	Downwind (ref: upwind)	Post-CSD (ref: pre-CSD)	High active well count (ref: low)	High inactive well count (ref: low)	High BOE (ref: low)
Exposed (vs. not)	-0.10 [-0.16, -0.03]	0.14 [0.05, 0.23]	-0.07 [-0.19, 0.05]	0.02 [-0.06, 0.09]	-0.05 [-0.17, 0.07]
Age (vs.20-24 years)					
25-29 years	-0.04 [-0.10, 0.03]	-0.03 [-0.10, 0.03]	-0.04 [-0.1, 0.03]	-0.04 [-0.1, 0.03]	-0.04 [-0.1, 0.03]
30-34 years	-0.13 [-0.19, -0.06]	-0.12 [-0.19, -0.06]	-0.12 [-0.19, -0.06]	-0.12 [-0.19, -0.06]	-0.12 [-0.19, -0.06]
34 years or older	-0.31 [-0.38, -0.23]	-0.30 [-0.38, -0.23]	-0.31 [-0.38, -0.23]	-0.31 [-0.38, -0.23]	-0.31 [-0.38, -0.23]
20 years or younger	-0.03 [-0.11, 0.06]	-0.03 [-0.11, 0.06]	-0.03 [-0.11, 0.06]	-0.03 [-0.11, 0.06]	-0.03 [-0.11, 0.06]
Female (vs. male)	0.14 [0.10, 0.18]	0.14 [0.10, 0.18]	0.14 [0.1, 0.18]	0.14 [0.1, 0.18]	0.14 [0.1, 0.18]
Education (vs. college or higher)					
HS graduate / some college	-0.12 [-0.18, -0.07]	-0.13 [-0.18, -0.07]	-0.13 [-0.18, -0.07]	-0.12 [-0.18, -0.07]	-0.13 [-0.18, -0.07]
Less than HS	-0.08 [-0.16, 0.00]	-0.08 [-0.16, 0.00]	-0.08 [-0.16, -0.01]	-0.08 [-0.16, 0]	-0.08 [-0.16, -0.01]
Insurance (vs. Private)					
Public	-0.09 [-0.14, -0.04]	-0.09 [-0.14, -0.04]	-0.09 [-0.14, -0.04]	-0.09 [-0.14, -0.04]	-0.09 [-0.14, -0.04]
Unknown	0.06 [-0.09, 0.21]	0.06 [-0.09, 0.21]	0.06 [-0.09, 0.21]	0.06 [-0.09, 0.21]	0.06 [-0.09, 0.21]
US born (vs. not)	0.01 [-0.05, 0.07]	0.06 [-0.01, 0.12]	0.01 [-0.05, 0.06]	0.01 [-0.05, 0.06]	0.01 [-0.05, 0.06]
Parity (vs. first born)	-0.15 [-0.19, -0.10]	-0.15 [-0.19, -0.11]	-0.15 [-0.19, -0.11]	-0.15 [-0.19, -0.11]	-0.15 [-0.19, -0.11]
Race / Ethnicity (vs. Asian Pacific)					
Black	-0.03 [-0.11, 0.06]	-0.04 [-0.12, 0.05]	-0.04 [-0.12, 0.05]	-0.04 [-0.12, 0.05]	-0.04 [-0.12, 0.05]
Hispanic	0.05 [-0.04, 0.13]	0.04 [-0.04, 0.12]	0.03 [-0.05, 0.12]	0.03 [-0.05, 0.12]	0.03 [-0.05, 0.12]
White	0.30 [0.22, 0.39]	0.30 [0.22, 0.39]	0.3 [0.22, 0.39]	0.3 [0.22, 0.39]	0.3 [0.22, 0.39]
Other	0.04 [-0.05, 0.13]	0.06 [-0.04, 0.16]	0.03 [-0.06, 0.13]	0.03 [-0.06, 0.13]	0.03 [-0.06, 0.13]
Year of birth	0.00 [-0.01, 0.00]	-0.01 [-0.02, -0.01]	0 [-0.01, 0]	0 [-0.01, 0]	0 [-0.01, 0]
Season of birth (vs. Fall)					
Spring	-0.03 [-0.08, 0.03]	-0.03 [-0.08, 0.03]	-0.03 [-0.08, 0.03]	-0.03 [-0.08, 0.03]	-0.03 [-0.08, 0.03]
Summer	-0.03 [-0.08, 0.03]	-0.03 [-0.08, 0.03]	-0.03 [-0.08, 0.03]	-0.03 [-0.08, 0.03]	-0.03 [-0.08, 0.03]
Winter	-0.02 [-0.08, 0.03]	-0.02 [-0.08, 0.03]	-0.02 [-0.08, 0.03]	-0.02 [-0.08, 0.03]	-0.02 [-0.08, 0.03]
Prenatal care (vs. Adequate)					
Inadequate	0.06 [-0.11, 0.23]	0.06 [-0.11, 0.23]	0.06 [-0.11, 0.23]	0.06 [-0.11, 0.23]	0.06 [-0.11, 0.23]
Intermediate	0.34 [0.17, 0.52]	0.35 [0.17, 0.52]	0.34 [0.17, 0.52]	0.34 [0.17, 0.52]	0.34 [0.17, 0.52]
Adequate plus	-0.05 [-0.42, 0.31]	-0.06 [-0.42, 0.31]	-0.06 [-0.42, 0.31]	-0.06 [-0.42, 0.31]	-0.06 [-0.42, 0.31]

Green Space	0.31 [-0.13, 0.75]	-0.07 [-0.42, 0.29]	-0.04 [-0.4, 0.32]	-0.08 [-0.44, 0.27]	-0.05 [-0.41, 0.31]
Traffic	0.00 [0.00, 0.00]	0.00 [0.00, 0.00]	0 [0, 0]	0 [0, 0]	0 [0, 0]
Ratio of Income to Poverty Line	0.01 [-0.11, 0.13]	-0.07 [-0.18, 0.04]	-0.07 [-0.18, 0.04]	-0.06 [-0.17, 0.05]	-0.07 [-0.18, 0.04]

Table 8: Mean difference in birthweight z-score and 95% confidence intervals from linear regression models. BOE = barrels of oil equivalent, CSD = Community Standards District

	Downwind (ref: upwind)	Post-CSD (ref: pre-CSD)	High active well count (ref: low)	High inactive well count (ref: low)	High BOE (ref: low)
Exposed (vs. not)	0.01 [-0.02, 0.04]	0.05 [0.01, 0.09]	-0.01 [-0.06, 0.05]	-0.01 [-0.04, 0.03]	0 [-0.06, 0.06]
Age (vs.20-24 years)					
25-29 years	0.04 [0.01, 0.07]	0.04 [0.01, 0.07]	0.04 [0.01, 0.07]	0.04 [0.01, 0.07]	0.04 [0.01, 0.07]
30-34 years	0.07 [0.04, 0.10]	0.07 [0.04, 0.10]	0.07 [0.04, 0.1]	0.07 [0.04, 0.1]	0.07 [0.04, 0.1]
34 years or older	0.06 [0.03, 0.10]	0.06 [0.03, 0.10]	0.06 [0.03, 0.1]	0.06 [0.03, 0.1]	0.06 [0.03, 0.1]
20 years or younger	-0.04 [-0.08, 0.00]	-0.04 [-0.08, 0.00]	-0.04 [-0.08, 0]	-0.04 [-0.08, 0]	-0.04 [-0.08, 0]
Female (vs. male)	0.01 [-0.01, 0.03]	0.01 [-0.01, 0.03]	0.01 [-0.01, 0.03]	0.01 [-0.01, 0.03]	0.01 [-0.01, 0.03]
Education (vs. college or higher)					
HS graduate / some college	-0.01 [-0.04, 0.01]	-0.01 [-0.04, 0.01]	-0.01 [-0.04, 0.01]	-0.01 [-0.04, 0.01]	-0.01 [-0.04, 0.01]
Less than HS	-0.03 [-0.07, 0.01]	-0.03 [-0.07, 0.01]	-0.03 [-0.07, 0.01]	-0.03 [-0.07, 0.01]	-0.03 [-0.07, 0.01]
Insurance (vs. Private)					
Public	-0.05 [-0.07, -0.03]	-0.05 [-0.07, -0.03]	-0.05 [-0.07, -0.03]	-0.05 [-0.07, -0.03]	-0.05 [-0.07, -0.03]
Unknown	0.05 [-0.02, 0.12]	0.05 [-0.02, 0.12]	0.05 [-0.02, 0.12]	0.05 [-0.02, 0.12]	0.05 [-0.02, 0.12]
US born (vs. not)	0.01 [-0.01, 0.04]	0.03 [0.00, 0.06]	0.01 [-0.01, 0.04]	0.01 [-0.01, 0.04]	0.01 [-0.01, 0.04]
Parity (vs. first born)	0.18 [0.16, 0.20]	0.18 [0.16, 0.20]	0.18 [0.16, 0.2]	0.18 [0.16, 0.2]	0.18 [0.16, 0.2]
Race / Ethnicity (vs. Asian Pacific)					
Black	0.09 [0.05, 0.13]	0.10 [0.06, 0.14]	0.1 [0.05, 0.14]	0.1 [0.05, 0.14]	0.1 [0.05, 0.14]
Hispanic	0.27 [0.23, 0.31]	0.27 [0.23, 0.31]	0.27 [0.23, 0.31]	0.27 [0.23, 0.31]	0.27 [0.23, 0.31]
White	0.31 [0.27, 0.35]	0.31 [0.27, 0.35]	0.31 [0.27, 0.35]	0.31 [0.27, 0.35]	0.31 [0.27, 0.35]
Other	0.17 [0.13, 0.22]	0.18 [0.14, 0.23]	0.18 [0.13, 0.22]	0.18 [0.13, 0.22]	0.18 [0.13, 0.22]
Year of birth	-0.01 [-0.01, -0.01]	-0.01 [-0.01, -0.01]	-0.01 [-0.01, -0.01]	-0.01 [-0.01, -0.01]	-0.01 [-0.01, -0.01]
Season of birth (vs. Fall)					
Spring	0.04 [0.01, 0.07]	0.04 [0.01, 0.07]	0.04 [0.01, 0.07]	0.04 [0.01, 0.07]	0.04 [0.01, 0.07]
Summer	0.03 [0.01, 0.06]	0.03 [0.01, 0.06]	0.03 [0.01, 0.06]	0.03 [0.01, 0.06]	0.03 [0.01, 0.06]
Winter	0.03 [0.00, 0.05]	0.03 [0.00, 0.05]	0.03 [0, 0.05]	0.03 [0, 0.05]	0.03 [0, 0.05]
Prenatal care (vs. Adequate)					
Inadequate	-0.01 [-0.09, 0.07]	-0.01 [-0.09, 0.07]	-0.01 [-0.09, 0.07]	-0.01 [-0.09, 0.07]	-0.01 [-0.09, 0.07]
Intermediate	0.03 [-0.06, 0.11]	0.03 [-0.06, 0.11]	0.03 [-0.06, 0.11]	0.03 [-0.06, 0.11]	0.03 [-0.06, 0.11]
Adequate plus	0.00 [-0.17, 0.18]	0.00 [-0.17, 0.18]	0 [-0.17, 0.18]	0 [-0.17, 0.18]	0 [-0.17, 0.18]

Green Space	0.13 [-0.08, 0.34]	0.18 [0.01, 0.36]	0.19 [0.01, 0.36]	0.19 [0.01, 0.36]	0.18 [0.01, 0.36]
Traffic	0.00 [0.00, 0.00]	0.00 [0.00, 0.00]	0 [0, 0]	0 [0, 0]	0 [0, 0]
Ratio of Income to Poverty Line	-0.04 [-0.09, 0.02]	-0.02 [-0.08, 0.03]	-0.03 [-0.08, 0.03]	-0.03 [-0.08, 0.03]	-0.02 [-0.08, 0.03]

Table 9: Birth outcomes by high vs. low drill rigs within 0.5 miles from the IOF boundary (N = 1636), air toxics (N = 838), and total chemicals (N = 838). BOE = barrels of oil equivalent, BW-Z= birthweight z-score, SD = standard deviation =, SGA = small for gestational age

	Drill rigs (N = 1636)		Air toxics (N = 838)		Total chemicals (N = 838)	
	Low (≤ 9.5) (N=876)	High (> 9.5) (N=760)	Low (≤63451) (N=423)	High (>63451) (N=415)	Low (≤87239) (N=424)	High (>87239) (N=414)
Preterm birth, N (%)	63 (7.2%)	43 (5.7%)	27 (6.4%)	30 (7.2%)	27 (6.4%)	30 (7.2%)
SGA, N (%)	66 (7.5%)	68 (8.9%)	36 (8.5%)	23 (5.5%)	36 (8.5%)	23 (5.6%)
Gestational age (weeks), mean (SD)	39 (2.0)	39 (1.8)	39 (1.9)	39 (1.9)	39 (1.9)	39 (1.9)
BW-Z (grams), mean (SD)	-0.040 (0.85)	-0.11 (0.84)	-0.065 (0.86)	-0.013 (0.82)	-0.072 (0.85)	-0.0056 (0.82)

* P-value < 0.05, two-proportional z test for counts/proportions, and two-sample t test for continuous variables
** P-value <0.01, two-proportional z test for counts/proportions, and two-sample t test for continuous variable

Table 10: Association between dichotomous outcomes and distance to IOF. Logistic regression models are stratified by wind direction and adjust for sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate. CI = confidence interval, IOF = Inglewood oil field, OR = odds ratio, SGA = small-for-gestational-age

	Preterm Birth OR [95% CI]	SGA OR [95% CI]	Gestational age (weeks) Mean difference (95% CI)	Birthweight z-score Mean difference (95% CI)
Distance (miles)	1.07 [0.92, 1.25]	0.96 [0.84, 1.11]	0.01 [-0.02, 0.04]	-0.10 [-0.16, -0.03]
Downwind	1.22 [1.06, 1.41]	0.95 [0.83, 1.08]	0.02 [-0.02, 0.05]	0.00 [-0.07, 0.07]
Age				
25-29 years	1.02 [0.88, 1.18]	0.96 [0.84, 1.09]	0.04 [0.01, 0.07]	-0.04 [-0.10, 0.03]
30-34 years	1.20 [1.04, 1.40]	0.96 [0.84, 1.09]	0.07 [0.04, 0.10]	-0.13 [-0.19, -0.06]
34 years or older	1.68 [1.44, 1.96]	1.00 [0.87, 1.15]	0.06 [0.03, 0.10]	-0.31 [-0.38, -0.23]
20 years or younger	1.08 [0.90, 1.30]	1.12 [0.96, 1.31]	-0.04 [-0.08, 0.01]	-0.03 [-0.11, 0.06]
Female	0.81 [0.74, 0.88]	0.97 [0.89, 1.04]	0.01 [-0.01, 0.03]	0.14 [0.10, 0.18]
Education				
HS graduate / some college	1.37 [1.21, 1.55]	1.12 [1.01, 1.26]	-0.01 [-0.04, 0.01]	-0.12 [-0.18, -0.07]
Less than HS	1.29 [1.09, 1.54]	1.18 [1.01, 1.38]	-0.03 [-0.07, 0.01]	-0.08 [-0.16, 0.00]
Insurance				
Public	1.08 [0.97, 1.21]	1.13 [1.02, 1.25]	-0.05 [-0.08, -0.03]	-0.09 [-0.14, -0.04]
Unknown	1.19 [0.86, 1.65]	1.21 [0.91, 1.61]	0.05 [-0.02, 0.12]	0.06 [-0.09, 0.21]
US born	1.15 [1.01, 1.32]	1.01 [0.90, 1.13]	0.01 [-0.01, 0.04]	0.01 [-0.05, 0.07]
Parity	0.94 [0.86, 1.04]	0.63 [0.57, 0.68]	0.18 [0.16, 0.20]	-0.15 [-0.19, -0.10]
Race / Ethnicity				
Black	1.10 [0.91, 1.32]	0.95 [0.81, 1.10]	0.09 [0.05, 0.14]	-0.03 [-0.11, 0.06]
Hispanic	0.93 [0.77, 1.12]	0.61 [0.52, 0.72]	0.27 [0.23, 0.31]	0.05 [-0.04, 0.13]
White	0.75 [0.61, 0.92]	0.56 [0.47, 0.66]	0.31 [0.27, 0.35]	0.30 [0.22, 0.39]
Other	1.06 [0.86, 1.31]	0.71 [0.60, 0.85]	0.18 [0.13, 0.22]	0.04 [-0.05, 0.14]
Year of birth	0.98 [0.97, 0.99]	1.01 [1.00, 1.02]	-0.01 [-0.01, -0.01]	0.00 [-0.01, 0.00]
Season of birth				
Spring	1.07 [0.94, 1.20]	0.90 [0.81, 1.00]	0.04 [0.01, 0.07]	-0.03 [-0.08, 0.03]
Summer	1.06 [0.94, 1.20]	0.85 [0.76, 0.95]	0.03 [0.01, 0.06]	-0.03 [-0.08, 0.03]
Winter	1.07 [0.95, 1.21]	0.93 [0.84, 1.04]	0.03 [0.00, 0.05]	-0.02 [-0.08, 0.03]
Prenatal care				
Inadequate	0.81 [0.58, 1.14]	1.00 [0.72, 1.40]	-0.01 [-0.09, 0.07]	0.06 [-0.11, 0.23]
Intermediate	0.54 [0.38, 0.76]	0.95 [0.67, 1.34]	0.03 [-0.06, 0.11]	0.34 [0.17, 0.52]
Adequate plus	1.45 [0.76, 2.74]	1.65 [0.88, 3.09]	0.00 [-0.17, 0.18]	-0.05 [-0.42, 0.31]
NDVI	0.63 [0.24, 1.69]	0.79 [0.32, 1.95]	0.15 [-0.07, 0.37]	0.31 [-0.14, 0.76]
Traffic	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]	0.00 [0.00, 0.00]	0.00 [0.00, 0.00]

Ratio of Income to Poverty Line	0.79 [0.60, 1.04]	1.19 [0.93, 1.54]	-0.04 [-0.11, 0.02]	0.01 [-0.12, 0.14]

Figure 1: Map of the study area

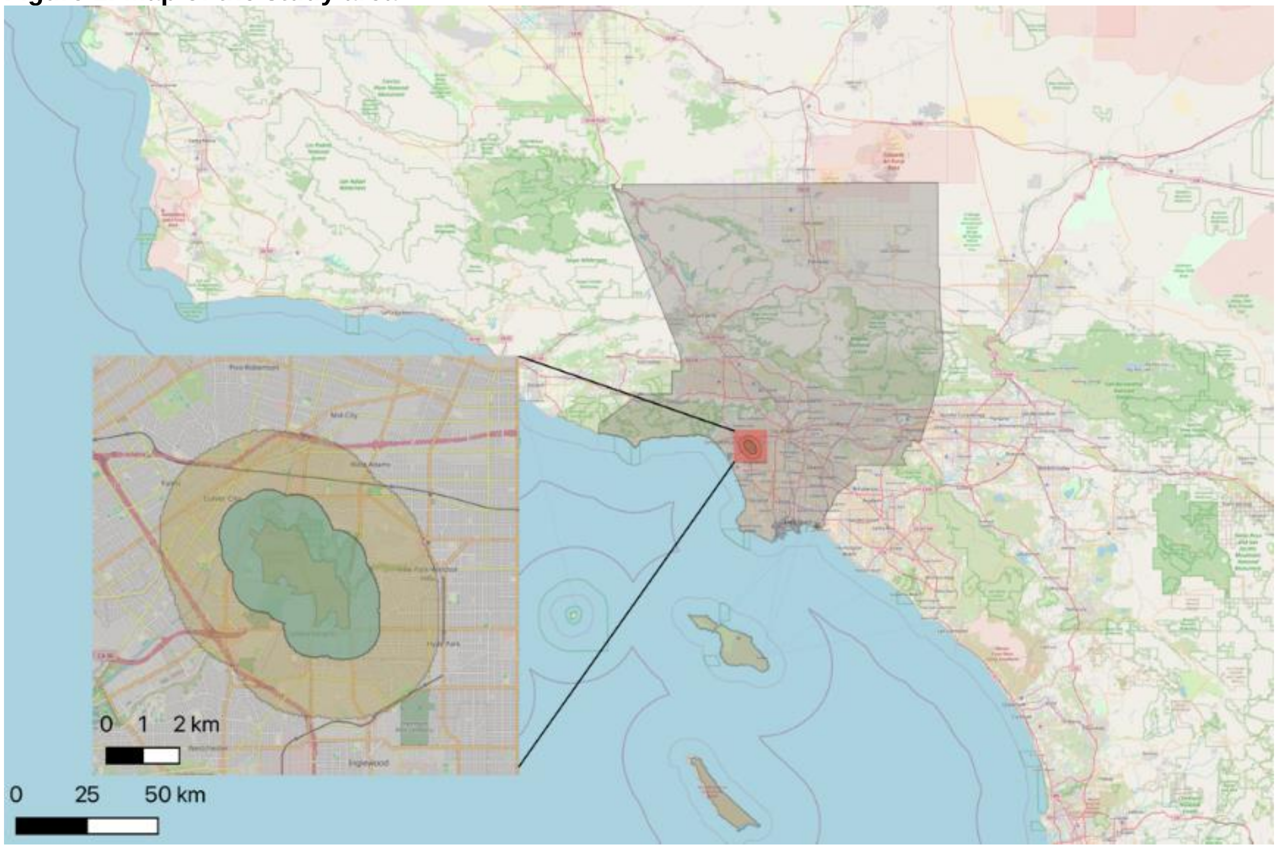


Figure 2: Wind rose displaying speed and direction from which the wind blows, IOF meteorological station, 2015-2019. Source: MRS Environmental

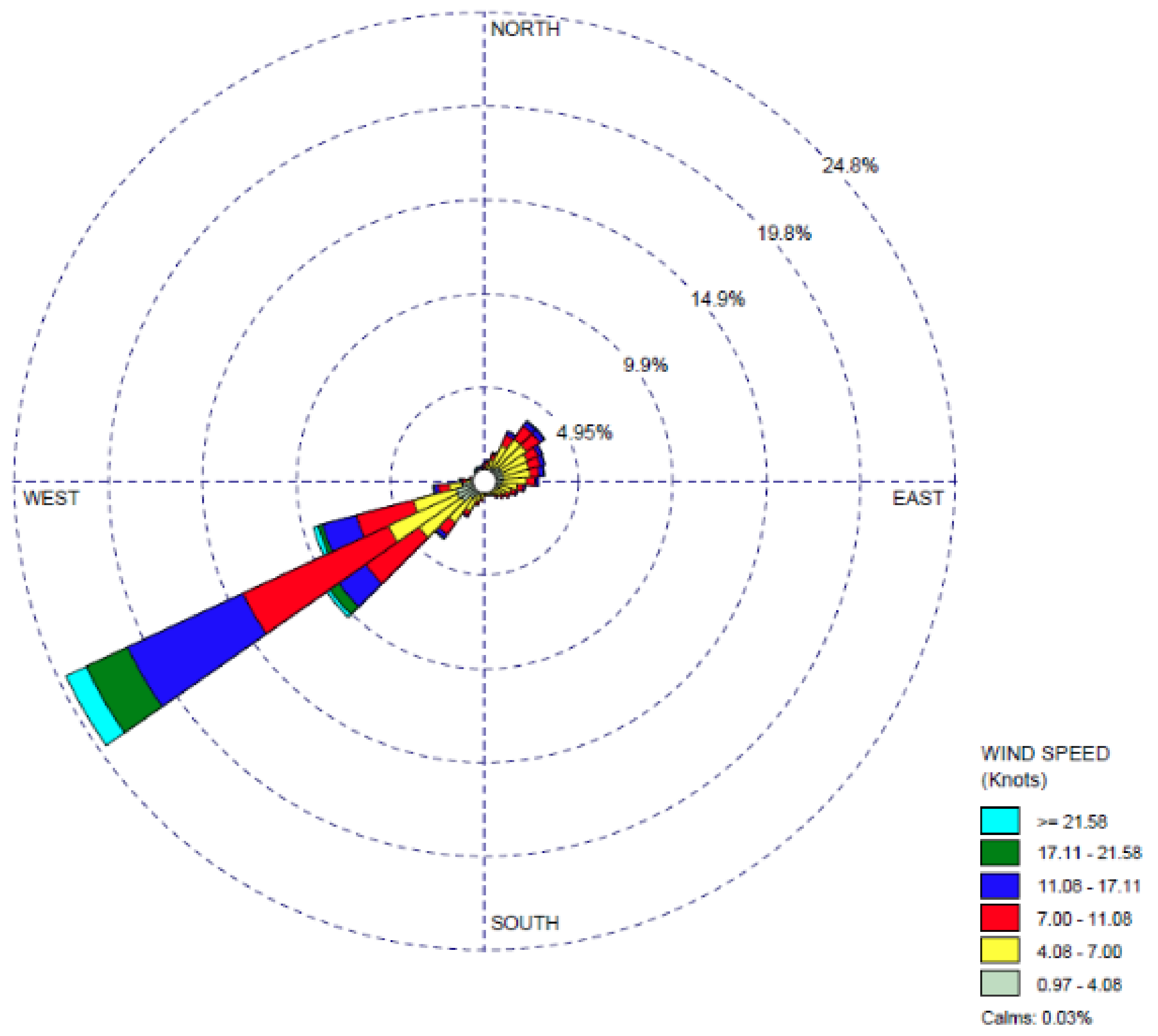


Figure 3: Construction of the study population. Note that numbers may not sum because some birth records were excluded for multiple reasons

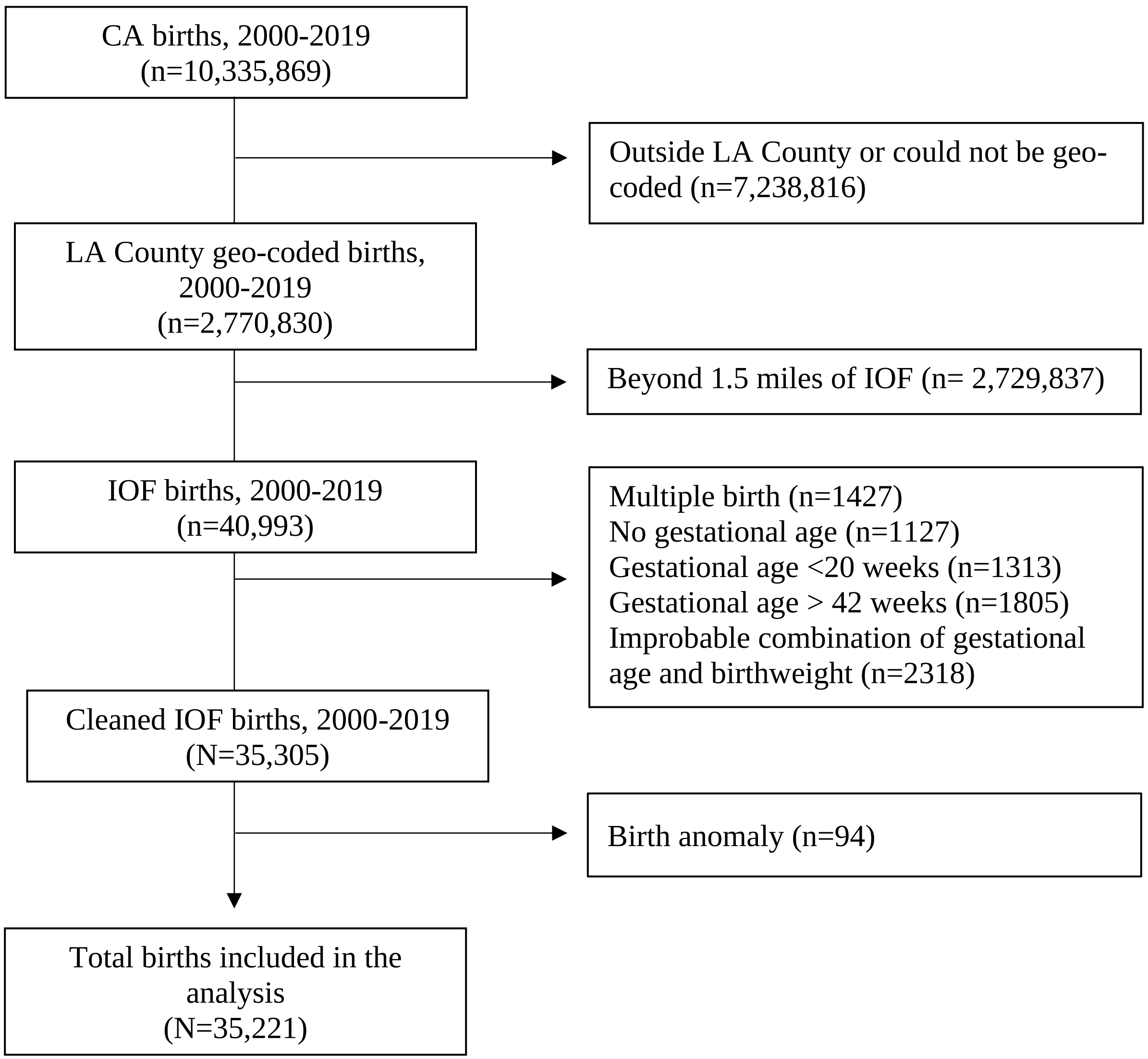


Figure 4: Odds of preterm birth associated with (a) wind direction, (b) post- vs. pre-CSD, and (c) OG activity within 0.5 miles. Diamonds indicate the OR, error bars the 95% CI, and red dashed lines the null. All models adjust for sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate. CI = confidence interval, CSD = Community Standards District, OG = oil and gas, OR = odds ratio

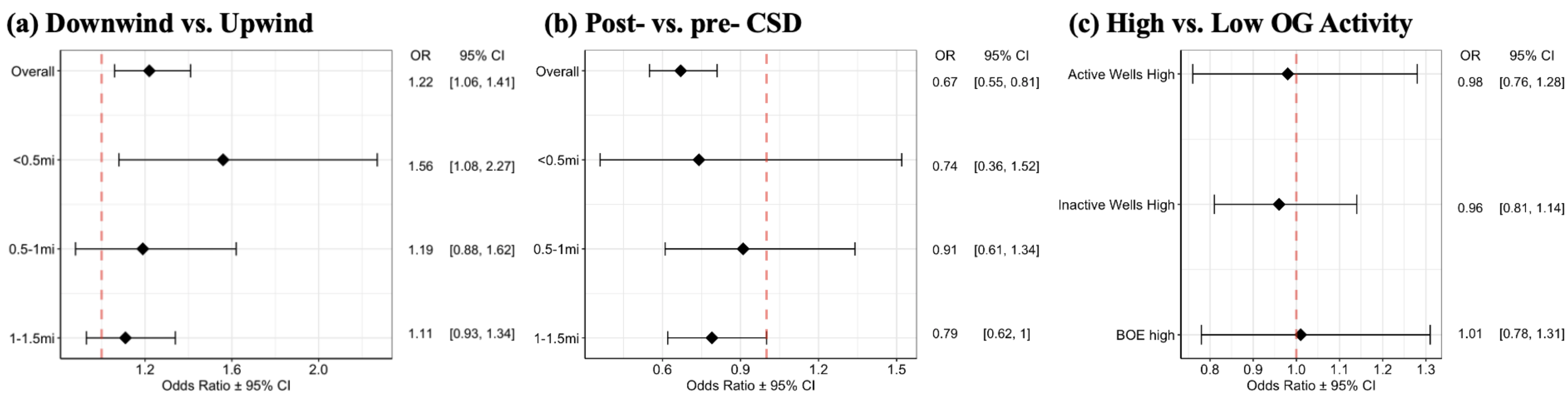


Figure 5: Odds of SGA associated with (a) wind direction, (b) post- vs. pre-CSD, and (c) OG activity within 0.5 miles. Diamonds indicate the OR, error bars the 95% CI, and red dashed lines the null. Models adjust for sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate. CI = confidence interval, CSD = Community Standards District, OG = oil and gas, OR = odds ratio, SGA = small-for-gestational-age

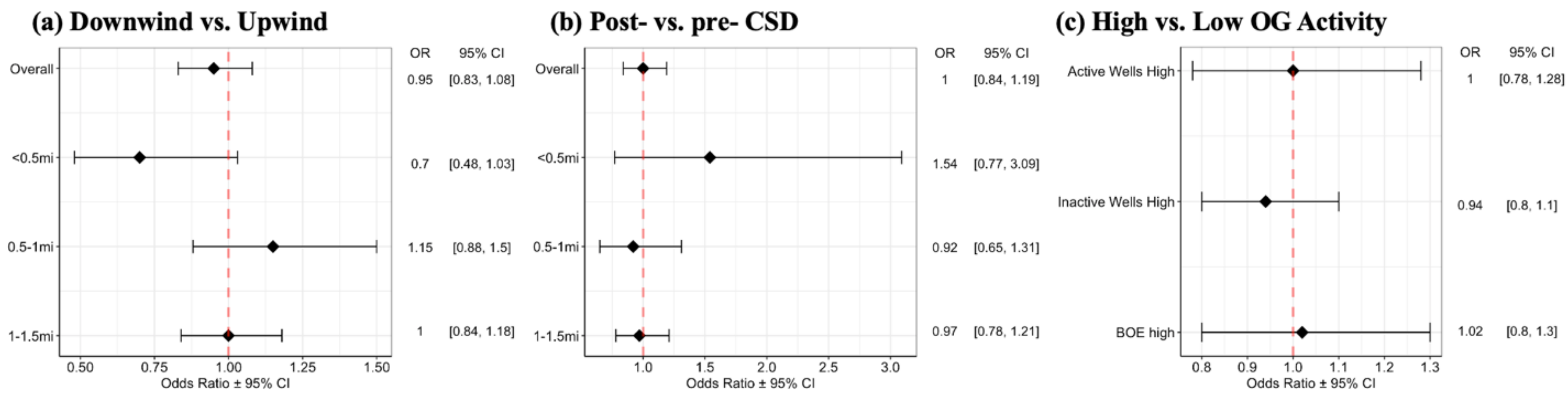


Figure 6: Mean difference in gestational age in weeks associated with (a) wind direction, (b) post- vs. pre-CSD, and (c) OG activity within 0.5. Diamonds indicate the OR, error bars the 95% CI, and red dashed lines the null. Models adjust for sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate. CI = confidence interval, CSD = Community Standards District, OG = oil and gas, OR = odds ratio, SGA = small-for-gestational-age

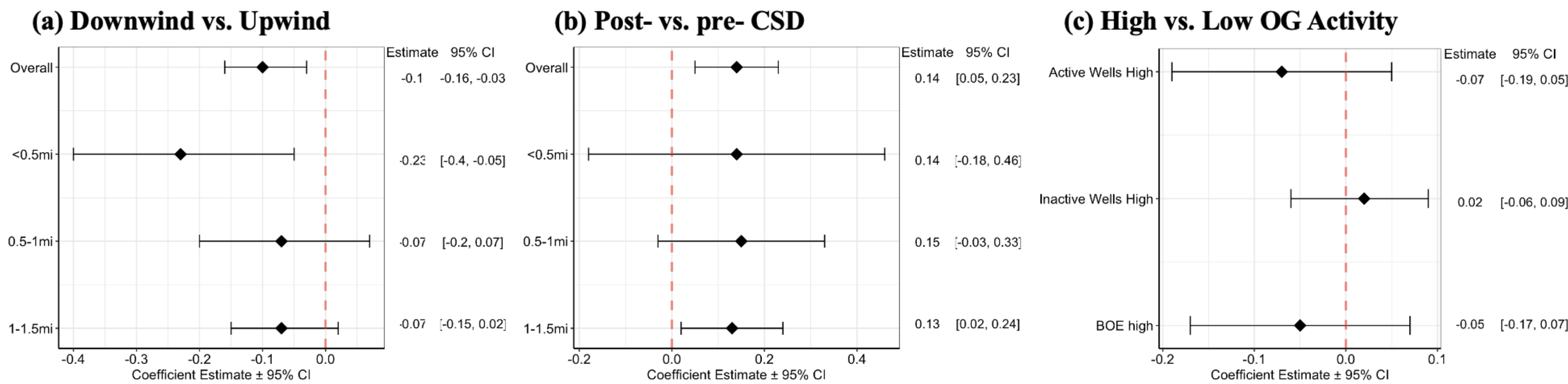


Figure 7: Mean difference in birthweight z-score associated with (a) wind direction, (b) post- vs. pre-CSD, and (c) OG activity within 0.5 miles. Diamonds indicate the OR, error bars the 95% CI, and red dashed lines the null. Models adjust for sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate. CI = confidence interval, CSD = Community Standards District, OG = oil and gas, OR = odds ratio, SGA = small-for-gestational-age

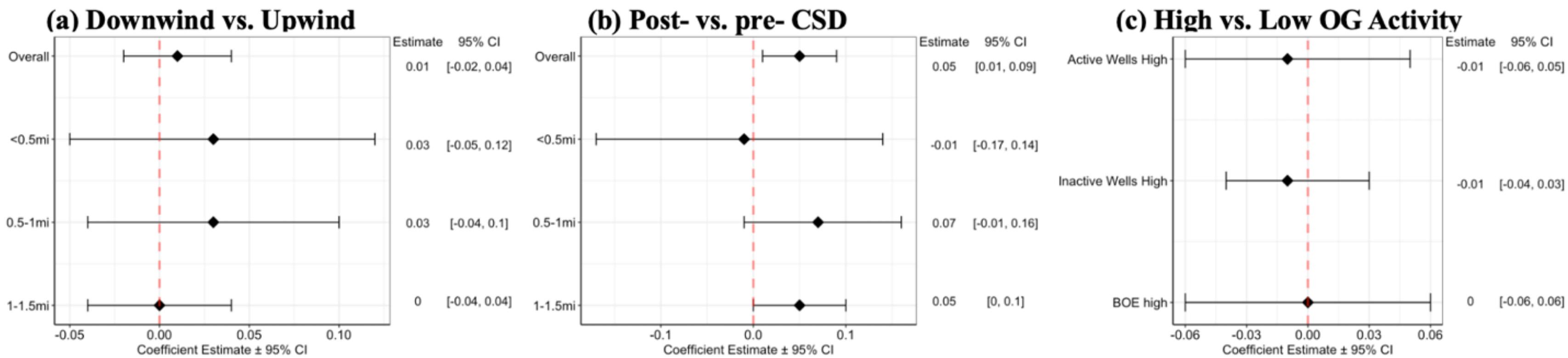


Figure 8: Odds of (a) preterm birth and (b) SGA associated with drill rigs, air toxics, and total chemicals. Diamonds indicate the OR, error bars the 95% CI, and red dashed lines the null. All models adjust for sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate. CI = confidence interval, OR = odds ratio, SGA = small-for-gestational-age

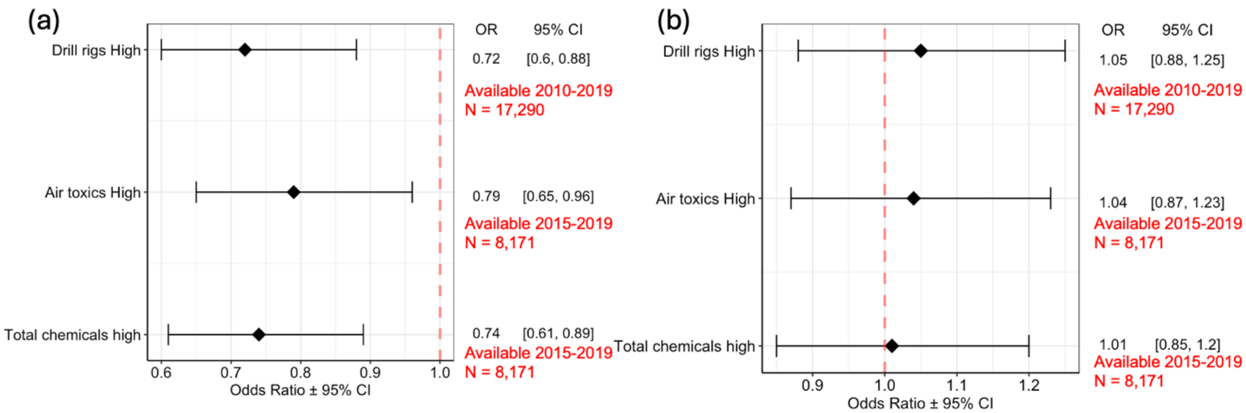
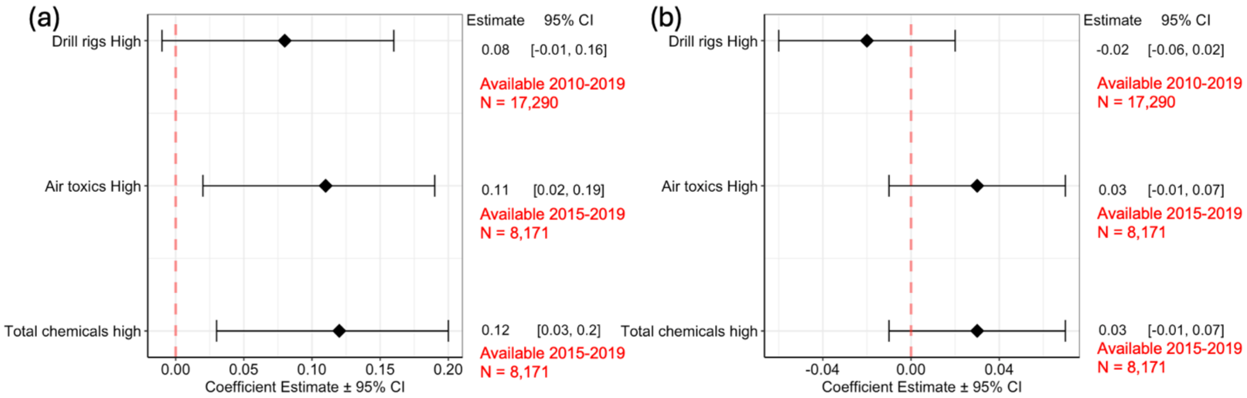


Figure 9: Mean difference in (a) gestation age in weeks and (b) birthweight z-score associated with drill rigs, air toxics, and total chemicals. Diamonds indicate the mean difference, error bars the 95% CI, and red dashed lines the null. Models adjust for sex, age, parity, nativity, race/ethnicity, education, insurance, season, year, green space, traffic and neighborhood poverty rate. CI = confidence interval



3. Household Survey and Biometric Measures

3.1. Introduction

The study aimed to investigate potential health impacts of oil field pollutants on residents living near the IOF in Baldwin Hills, focusing on both short- and long-term health outcomes. To achieve this, the research team conducted a household survey and gathered biometric data from individuals residing within 1.5 miles of the oil field. The primary objective was to estimate relative exposure levels to pollutants and their correlation with self-reported respiratory health, cardiovascular health, and quality of life among local residents. Biometric measurements of lung function and blood pressure were collected to complement survey data and provide objective health indicators.

The study used a combination of stratified random sampling using address-based sampling (ABS), and convenience sampling. The research team divided the sampling area into three strata based on proximity to the oil wells: 0-0.5 mile, 0.5-1.0 mile and 1-1.5 mile distance from the IOF fence line. Data collection methods included both household surveys and biometric assessments of lung function and blood pressure, offering a comprehensive view of potential health impacts. To ensure scientific rigor, the design incorporated stratification based on distance from the oil field, with some oversampling of underrepresented racial and ethnic as well as low-income groups, where necessary, to ensure broad representation. Additionally, the study integrated a combination of traditional epidemiological methods and advanced data analysis techniques, including regression modeling, to assess the relationship between pollutant exposure and health outcomes.

3.2. Methods

Sampling Strategy, Recruitment Process, Consent, and Incentive

Recruitment Process

The research team used both random and convenience sampling methods to invite individuals to participate in the study. The random sampling was done through address-based sampling stratified by three factors of distance to IOF, race/ethnicity, and income. A total of 15,000 letters were mailed to randomly selected households through three separate 5,000-letter batches sent in June, July, and November 2023. From July to September 2023, the research team also hand-delivered 300-400 letters to randomly selected households within the study boundaries.

Based on the pace and insufficient response level of the random selection mailing recruitment, in August 2023, the research team also added convenience sampling recruitment to improve the pace of recruitment and participation numbers. The team first reached out to local organizations including but not limited to libraries, coffee shops, and local government accounts (e.g., Culver City Instagram account) to ask if they could share the study information virtually or through recruitment flyers. Flyers were provided for parents of students attending local schools including Hillcrest Drive Elementary School, Susan Miller Dorsey Senior High School, Stella Middle Charter Academy, and to the administrative staff at Antioch University Los Angeles in Culver City. Outreach flyers and posts were provided in both English and Spanish to recruitment organizations/sites.

The research team also engaged in recruitment efforts at a Sentinel Peak Resources event at the IOF, a Stoneview Nature Center community event, a yoga session at Kenneth Hahn State Recreation Area, the West Los Angeles College (WLAC) October 24, 2023, Climate Action Day, and a council meeting held by the Empowerment Congress West Area (ECWA). Participants were also recruited via social media (e.g., Instagram and Facebook), Homeowners Association (HOA) listserv emails, neighborhood apps (e.g., Nextdoor), and community events hosted by the HOAs. To maximize online recruitment efforts, advertisements were run on Facebook and Instagram.

Consent

Consent to collect data was obtained from each participant through the online consent form made available through Research Electronic Data Capture (REDCap). REDCap is a secure, web application designed to build and manage online surveys, data collection forms, and databases for research studies (Research Electronic Data Capture (REDCap), 2024). REDCap provides automated export procedures for use with Excel and common statistical packages, and also has the ability to build real-time reports that monitor completeness and quality of data (Research Electronic Data Capture (REDCap), 2024). The consent form asked participants to enter their name, subject I.D., date, and signature. The information provided on the consent form included: purpose of the study, list of tasks for a participant to complete, risk-benefits analysis, confidentiality statement, use of data for future research statement, participants' rights statement, and study team contact information. The research team assisted participants in completing the consent form over the phone or at data collection sites as needed.

Participant Compensation

Participants were compensated with a $20 gift card after completing both the biometric data collection and the household survey. Participants either received a physical gift card (e.g., US Bank or Amazon) or an online $20 Amazon electronic gift card link depending on when they finished the data collection.

Household Survey

Questionnaire Development

The household survey questionnaire was developed through a scientific and rigorous process that included an extensive literature review and preliminary assessments to identify key health concerns related to oil field pollutants. The research team reviewed and referenced multiple existing surveys in other environmental health studies, such as the LAC Health Survey, prior wave of The Baldwin Hills Health Assessment and Environmental Justice study conducted in 2011-2012, "Changes in Neighborhood Air Quality After Idling of an Urban Oil Production Site" and "Respiratory Health, Pulmonary Function, and Local Engagement in Urban Communities Near Oil Development," studies both led by Dr. Jill E. Johnson, as well as surveys conducted by the California Office of Environmental Health Hazard Assessment (OEHHA). These prior surveys provided relevant information about domains and survey items, such as respiratory and cardiovascular health outcomes, and environmental justice concerns in communities near oil fields. When the survey was developed, it was also reviewed by the CHAAP members during the monthly meeting, ensuring that it addressed the concerns, needs, and unique characteristics of the Baldwin Hills community.

Survey Administration

The structured household survey was administered via the QDS-Web online platform to capture information about participants' demographic characteristics, environmental exposures, self-reported health, symptoms, diagnoses, behaviors, living conditions, and others. The survey consisted of 168 questions and took approximately 30 to 45 minutes to complete in one sitting (See Attachment 5 in Appendix for the Household Survey).

Participants received an invitation letter containing information on how to access the survey. The letter included a direct link to the survey and also a QR code for easy access which offers an alternative method to access the survey via electronic devices. Before initiating the survey, participants were required to sign the online consent form.

Participants were encouraged to complete the survey at home when convenient to them. Surveys were also completed at data collection sites or over the phone depending on participants' preferences and requests. Research staff were available during data collection appointments to help guide participants through the survey and answer their questions.

Biometric Measures

Equipment and Tools

The research team used Spirolink spirometers for lung function testing. Each spirometer was equipped with a reusable mouthpiece. Before each use, reusable mouthpieces were washed with soap, rinsed with lukewarm water, and then air-dried. Spirometers were also sanitized between uses, following clinical hygiene standards. The research team used four Omron 3 Series Upper Arm, model BO7100 blood pressure monitors to measure participants' blood pressure. The monitors are clinically proven accurate and come with a wide range D-ring cuff that fits arms 9’’ to 17’’ in circumference.

Hygiene Supplies and Additional Equipment

Disposable gloves were used by the research staff when handling equipment and during interactions with participants to prevent direct contact with devices or participants and to maintain hygiene standards. After measuring each participant, the research staff disposed of gloves and used disinfectant wipes to clean surfaces between uses. The research staff used hand sanitizer between participants. Hand sanitizer was also made available for participants. Additionally, the research team provided tents, tables, and chairs at data collection sites. Tables were covered with tablecloths with a UCLA sign and logo and study posters were used on the tables to enhance the site's visibility. Laptops and tablets were made available for participants to consent to and/or to complete the survey.

Data Collection Procedures

Participants were invited to make appointments at various data collection sites where biometric data was collected. The research team checked in participants using their full name, current address, and subject I.D. Sessions lasted 2-4 hours long and were held on weekdays, weekends and individual appointments took 10-20 minutes. Data collection occurred across various locations from July 2023 to June 2024. The study team conducted a total of 96 data collection sessions over the 11-month period.

Data Collection through Community Events

Apart from the arranged weekly data collection locations, the study team also participated in community events, allowing those interested and residing within the study area to sign up and complete the consent forms. If time allowed, the research staff completed biometric data collection and resident health surveys at the event tables.

The research team also collaborated with Homeowners Associations and arranged two data collection events at two different apartment complexes in the Baldwin Hills area. These events were exclusively for residents and lasted around 3-4 hours. These efforts aimed to increase resident participation, provide flexible scheduling, and ensure comprehensive data collection.

Make Up Sessions

Makeup data collection sessions were conducted in May 2024 for participants who had completed the household survey but had not yet completed the biometric data collection. Phone calls and email reminders were sent to participants 1 to 2 days in advance and included the biometric data collection location and time they signed up for.

Data collection was originally expected to end by October 1st, 2023, but was first extended through December 2023 followed by a few more extensions between January and April 2024. Active recruitment of participants through convenience sampling was formally ended on April 30th, 2024.

Biometric Data Collection Approach

Biometric data collection consisted of two tests measuring blood pressure and lung function, respectively, taking approximately 10 to 20 minutes per study participant. These tests were conducted to provide a measure of health outcomes aside from self-reported health conditions reported in the household survey. The project coordinator for the study received formal instruction from a nurse regarding best practices for conducting blood pressure tests; in turn, the project coordinator trained other members of the research team based on this instruction. Training for the lung function test was adapted from the Spirolink website, where instructional videos outline the proper usage of the device. Team members trained by testing the device before using it with participants.

Blood Pressure Test

The blood pressure test consisted of three measurements using an Omron blood pressure machine. During each measurement, participants were instructed to remain still, sit upright, and refrain from speaking. There was a 1-minute break between each measurement. These measures were implemented to ensure consistency between measurements. The research team also took note of medications taken before the blood pressure test, and participants were instructed to rest for 5 minutes before measurements were taken if they had exercised prior to the data collection session. Blood pressure measurements were averaged per participant across the three measurements for each participant.

Lung Function Test

The lung function test consisted of three measurements using a Spirolink spirometer. The spirometer connected to the Spirolink mobile app, which created a profile for each participant and asked for each participant's height, weight, and date of birth. Participants' racial identifications were not entered to avoid racial correction bias as spirometers commonly include race-adjustment corrections, assuming a smaller lung capacity for minorities. Once the profile was made for each participant, a team member attached a mouthpiece to the Spirolink device. Then, the participant would be instructed to take three separate breaths into the mouthpiece. Each time, participants were asked to inhale as completely as possible, and then exhale forcefully until they no longer could breathe out. The team encouraged them to take a break between breaths and only do so when they were ready.

Data Management

Data Cleaning

During the data cleaning phase, we first removed participants with no geographical information, and those who reported home addresses more than 1.5 miles from the IOF boundary. We removed outliers in the biometric data where lung function or blood pressure were three standard deviations from the mean (average). For biometric data we used the mean of measured blood pressure and maximum of measured lung function throughout this report. BMI was calculated based on the participants self-reported height and weight. During the survey data cleaning phase, we removed duplicated and near-empty entries. We consolidated subcategories of certain variables and generated new measures by combining related variables, such as aggregating hours spent outdoors/indoors in the morning, afternoon, and evening to create a weekly outdoor hours variable. Responses of 'Don't know' and 'Prefer not to say' were classified as missing and excluded from the final analysis due to concerns about small counts.

We included three location-based variables calculated as follows: 1) wind direction: we defined downwind vs. upwind on the basis of 180° increments using meteorological data from 2015-2019 as was used in the birth outcome analysis; 2) Green space: Census-tract level normalized difference vegetation index (NDVI) was calculated using 2020 satellite imagery from the USGS National Agriculture Imagery Program as described elsewhere[13]. NDVI is an index of the degree of vegetative greenness that has been linked to better birth outcomes in prior studies[1]; 3) traffic: We filtered US primary, secondary, and local roads within 1.5 miles of the IOF boundary fence line. Among these, we sorted the roads by total length, and included 6-lane local roads in addition to primary and secondary roads. We then calculated the distance from resident addresses to these roads to determine if they were within 200 meters of any of the selected roads and summed the total roadway length within 200 meters of each address.

Definition of 'Exposed' and 'Unexposed' Groups Based on Distance from IOF and Wind Direction

We categorized exposure groups as either 'exposed' or 'unexposed' based on either distance from the IOF, wind direction, or a combination of both factors. For distance, we defined the area within 0.5 miles from the IOF boundary as the most exposed. We compared this to groups living 0.5-1 miles away and 1-1.5 miles away, with the latter being the least exposed. We also analyzed distance as a continuous variable. Regarding wind direction, we classified those downwind of the IOF as higher exposure group and those upwind as relatively lower exposure group.

Statistical Analysis

We first generated descriptive statistics for each of the measures. For continuous measures (e.g., age, FEV1, FVC), we calculated the mean (average) and median (middle data point), variation (standard deviation, etc.), percentiles and range (25%, 75%, 95%, minimum and maximum values). For categorical variables (e.g., gender, and race/ethnicity), we calculated the frequency distribution and modes (most frequent value). Several key demographic variables such as race/ethnicity, education, and income were compared to the American Community Survey (ACS) 2018-2022 five-year estimate of the residents of the same area to assess the level representativeness of our sample[4]. All census tracts whose center point fell within the 1.5 miles distance from the IOF boundary were included to calculate the weighted mean estimate for the purposes of comparing to our sample.

Bivariate analyses: We assessed the degree to which each outcome measure (e.g., FEV1, FVC, FEV1/FVC ratio, systolic and diastolic blood pressure, previous diagnosis of diseases and recent symptoms) varied with distance to the oil field using chi-square tests for categorical variables and t-test, analysis of variance (ANOVA) or marginal regressions for continuous measures. We evaluated differences in outcomes between residents living within a 0.5-mile radius, between 0.5 and less than 1 mile, and between 1 and less than 1.5 miles from the IOF boundary.

Multivariate modeling: In this report, the regression analysis was done using only participants for which we have complete data on both biometric and survey data due to the need to use measures from both of these data sources.

We used linear regression models to analyze the relationship between biometric outcomes (FEV1, FVC, systolic and diastolic blood pressure) and exposure, namely distance to the IOF (residents within a 0.5-mile radius, between 0.5 and 1 mile, and between 1 and 1.5 miles from the IOF, or continuous variable as miles from IOF) and wind direction (downwind versus upwind). For lung function measures, we 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, green space and traffic. Besides FEV1 and FVC, we also looked at abnormal lung function defined as FEV1/FVC ratio of less than 0.70 or either FEV1 or FVC below 80% of the predicted value (adjusted for age, gender, and height) [22,23].

Similarly for blood pressure versus exposure, the models adjusted for age, sex, race/ethnicity, education, hypertension diagnosis, years living in the neighborhood, BMI, ever smoker, gas stove, green space, and traffic. We also looked at binary outcomes of high blood pressure (defined as systolic blood pressure > 130mmHg or diastolic blood pressure > 80 mmHg)[24].

Logistic regression was employed to assess the association between environmental exposures and self-reported recent symptoms of sore throat and headache, adjusted for age, sex, race/ethnicity, education, asthma diagnosis, years living in the neighborhood, hours outdoor, BMI, season, ever smoker, gas stove, green space and traffic. Finally, we assessed the association between self-reported health conditions (high cholesterol, cancer of all types) and environmental exposure, adjusting for age, sex, race/ethnicity, education, ever smoker, BMI, gas stove usage, outdoor hours, years living in the neighborhood and traffic.

Additionally, we performed sensitivity analysis on how the length of residence affects these outcomes while controlling for the same variables by redoing analysis limiting to residence time longer than 5 years.

A $p<0.05$ was considered statistically significant for all statistical tests.

3.3. Results

Recruitment Results

Initially, address-based sampling was employed to recruit study participants. A total of 15,000 letters were sent to randomly selected households in three separate batches of 5,000 letters each, resulting in response rates of 1.5%, 1.7%, and 0.8%, respectively. These results demonstrated that mailing recruitment was not a viable strategy. The low response rates were attributed to a limited budget, a short study timeframe, community fatigue from responding to mailed survey requests from various studies over time, and the large number of individuals targeted. To mitigate these challenges, a convenience sampling approach was subsequently adopted.

Participants Overview and Representativeness

A total of 642 residents consented to participate in the study. After data cleaning (missing data, duplicates) we had 623 participants with either survey or biometric data: specifically, 588 participants completed the survey, 540 completed biometric data collection, and 520 completed both survey and biometric data collection. Table 11 presents characteristics of participants segmented by proximity to the IOF boundary, combining both results from the resident survey and self-reported information such as age from biometric data collection sites. Residents living closer to the oil field tended to be older (average age 58.3 among those living less than 0.5 miles from the oilfield compared to 44.5 for those 1.0-1.5 miles away) and to have resided in their homes longer (average years 17.2 versus 11.7 for these two groups, respectively). Higher percentages of those living nearer to the oil field were female (68.9% vs. 60.0%) and white (49.3% vs. 35.3%) while fewer were Hispanic or Latinx (3.3% vs 17.3%). Educational attainment was higher for those closer to the oil field 86.1% vs. 75.3%) as was smoking (19.1% vs 14.7%), but asthma diagnosis was lower 15.5% vs. 20.5%. In terms of environmental exposure, gas stove usage was highest among residents farthest from the oil field (80.1%) and residents living more than 1.0 mile from the IOF had a higher likelihood of being within 200 meters of traffic, 43.4% compared to 22.8% at less than 0.5 miles. Most biometric data collection happened in winter. Green space was less abundant at farther distances, with values lowest at 1.0-1.5 miles.

The comparison of the collected sample and the American Community Survey regarding race/ethnicity, poverty level, and education are summarized in Table 12. Overall, the respondents reflected the neighborhood community, but there was an overrepresentation of White respondents and underrepresentation of Hispanic/Latinx and lower-income groups in the study sample. There was a notable overrepresentation of individuals with higher educational attainment in our survey sample, which included participants as young as 18, compared to the ACS standard that only included those aged 25 and older. This age difference affected the comparison between our sample and ACS estimates. These variances may impact the generalizability of the study's findings to the broader community. Adjustments in future survey methodologies or analysis might be required for a more accurate community representation.

Table 11: Characteristics of participants by distance to the IOF

	<0.5 miles (N = 219)	0.5 – 1.0 miles (N = 238)	1.0 - 1.5 miles (N = 166)	Overall (N = 623)
Age (Mean (SD))	58.3 (16.2)	53.3 (17.2)	44.5 (16.3)	52.7 (17.5)
Missing	45 (20.5%)	35 (14.7%)	34 (20.5%)	114 (18.3%)
Sex at birth				
Female	144 (68.9%)	151 (65.9%)	90 (60.0%)	385 (65.5%)
Male	65 (31.1%)	78 (34.1%)	59 (39.3%)	202 (34.4%)
Prefer not to say	0 (0%)	0 (0%)	1 (0.7%)	1 (0.2%)
Race/Ethnicity				
Black / African American	49 (23.4%)	57 (24.9%)	29 (19.3%)	135 (23.0%)
Asian / Asian American	28 (13.4%)	22 (9.6%)	20 (13.3%)	70 (11.9%)
Hispanic or Latinx	7 (3.3%)	21 (9.2%)	26 (17.3%)	54 (9.2%)
Other	22 (10.5%)	22 (9.6%)	22 (14.7%)	66 (11.2%)
White	103 (49.3%)	107 (46.7%)	53 (35.3%)	263 (44.7%)
Education Attainment				
Completed college or higher	180 (86.1%)	186 (81.2%)	113 (75.3%)	479 (81.5%)
High school graduate or some college	26 (12.4%)	38 (16.6%)	33 (22.0%)	97 (16.5%)
Prefer not to say	3 (1.4%)	1 (0.4%)	1 (0.7%)	5 (0.9%)
Less than high school	0 (0%)	4 (1.7%)	3 (2.0%)	7 (1.2%)
BMI	26.5 (6.2)	25.9 (5.5)	26.9 (6.2)	26.4 (5.9)
Duration (years) of residence in current address (Mean (SD)**)**	17.2 (14.0)	14.2 (12.7)	11.7 (11.4)	14.7 (13.0)
Ever smoker				
Don't know	5 (2.4%)	4 (1.7%)	2 (1.3%)	11 (1.9%)
No	164 (78.5%)	177 (77.3%)	125 (83.3%)	466 (79.3%)
Yes	40 (19.1%)	47 (20.5%)	22 (14.7%)	109 (18.5%)
Prefer not to say	0 (0%)	1 (0.4%)	1 (0.7%)	2 (0.3%)
Diagnosis of Asthma				
No	173 (79.0%)	187 (78.6%)	116 (69.9%)	476 (76.4%)
Yes	34 (15.5%)	42 (17.6%)	34 (20.5%)	110 (17.7%)
Don't Know	2 (0.9%)	1 (0.4%)	1 (0.6%)	4 (0.6%)
Missing	10 (4.6%)	8 (3.4%)	15 (9.0%)	33 (5.3%)
Cough in the recent two weeks				

Yes	57 (26.0%)	66 (27.7%)	42 (25.3%)	165 (26.5%)
No	152 (69.4%)	164 (68.9%)	109 (65.7%)	425 (68.2%)
Missing	10 (4.6%)	8 (3.4%)	15 (9.0%)	33 (5.3%)
Allergic Hay fever, grass, pollen				
No	105 (47.9%)	109 (45.8%)	66 (39.8%)	280 (44.9%)
Yes	87 (39.7%)	94 (39.5%)	69 (41.6%)	250 (40.1%)
Don't Know	17 (7.8%)	27 (11.3%)	16 (9.6%)	60 (9.6%)
Missing	10 (4.6%)	8 (3.4%)	15 (9.0%)	33 (5.3%)
Stove Type				
Gas Stove	154 (70.3%)	178 (74.8%)	133 (80.1%)	465 (74.6%)
Electric Stove	52 (23.7%)	46 (19.3%)	15 (9.0%)	113 (18.1%)
Other	2 (0.9%)	4 (1.7%)	2 (1.2%)	8 (1.3%)
Don't Know	1 (0.5%)	2 (0.8%)	1 (0.6%)	4 (0.6%)
Missing	10 (4.6%)	8 (3.4%)	15 (9.0%)	33 (5.3%)
Direction from IOF				
Downwind	78 (37.3%)	158 (69.0%)	64 (42.7%)	300 (51.0%)
Upwind	131 (62.7%)	71 (31.0%)	86 (57.3%)	288 (49.0%)
Green Space				
Mean (SD)	0.07 (0.05)	0.09 (0.08)	0.01 (0.07)	0.06 (0.07)
Within 200m of Traffic				
Yes (%)	50 (22.8%)	52 (21.8%)	72 (43.4%)	174 (27.9%)
Sum of roadways within 200 meters (miles)	111 (232)	102 (212)	266 (355)	149 (273)
Season of Biometric Data Collection				
Autumn	47 (21.5%)	39 (16.4%)	30 (18.1%)	116 (18.6%)
Spring	4 (1.8%)	6 (2.5%)	8 (4.8%)	18 (2.9%)
Summer	36 (16.4%)	29 (12.2%)	21 (12.7%)	86 (13.8%)
Winter	103 (47.0%)	137 (57.6%)	80 (48.2%)	320 (51.4%)
Did not Complete Biometric Data Collection	29 (13.2%)	27 (11.3%)	27 (16.3%)	83 (13.3%)
Ever positive for COVID-19				
No	87 (39.7%)	76 (31.9%)	55 (33.1%)	218 (35.0%)
Yes	119 (54.3%)	150 (63.0%)	95 (57.2%)	364 (58.4%)
Don't Know	13 (5.9%)	12 (5.0%)	16 (9.6%)	41 (6.6%)

Table 12: Characteristics of household survey participants and block groups with center points within 1.5 miles of the IOF boundary from the 2018-2022 American Community Survey (ACS) 5-year estimates

	Household Survey (N = 590)	ACS (2022 5-yr estimate)
Race/Ethnicity		
African American	22.9%	27.2%
Asian / Pacific Islanders	11.9%	9.6%
Hispanic/Latinx	9.2%	31.7%
White	44.6%	25.7%
Other	11.5%	10.5%
Poverty		
Above twice the federal poverty level (FPL)	77.6%	74.7%
Below twice the FPL	9.2%	25.3%
Missing	13.2%	
Education		
Completed college or higher	81.2%	47.4%
High school (HS) graduate / some college	16.5%	40.1%
Less than HS	1.2%	12.4%
Prefer not to say	1.0%	

Note: The education in the ACS sample contained only those who are 25 years or older while the BHHAEJ included participants as young as 18.

Respiratory Outcomes

Overview and Descriptive Statistics

We utilized conservative thresholds based on FEV_1, FVC, and the FEV_1/FVC ratio measured during data collection sessions to define abnormal lung function. By applying these stringent criteria, individuals who meet any of these standards are classified as having impaired lung function, even if they fall within borderline ranges. This definition is likely more inclusive than clinical diagnosis of abnormal lung function. Lung function in this community was better among those living farther from the oil field, based on measurements of forced expiratory volume in one second (FEV1) and forced vital capacity (FVC). Specifically, the farther away from the oil field, the higher the average FEV1, with 2.20 liters among those living 0–0.5 miles from the oil field, 2.42 liters at 0.5–1.0 miles, and 2.62 liters at 1.0–1.5 miles (Table 13). Similarly, average FVC was 2.49 liters at 0-0.5 miles vs. 2.81 liters at 0.5-1.0 miles, and 3.02 liters at 1.0-1.5 miles. The abnormal lung function data also supported this pattern of results: participants living closest to the oil field (0-0.5 miles) had the highest rate of abnormal lung function, recorded at 66.9%, compared to 62.8% at 0.5-1.0 miles and 62.7% at 1.0-1.5 miles. While the ANOVA test indicated that the differences in FEV1 and FVC across distances were statistically significant (p-value < 0.05), we could not rule out that these differences might be due to chance for abnormal lung function rates, as all individual comparisons had p-values greater than 0.05. In summary, these findings suggest lung capacity was better among participants living at greater distance from the oil field, yet the evidence is not definitive enough to entirely dismiss the role of random variation.

Table 13: Average FEV and FVC and abnormal lung function rates for participants among different distances

	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

We also plotted biometric outcomes against distance to the IOF in miles as shown in Supplemental Figure 1. There is no evidence of a sharp cutoff or drastic changes in lung function (FVC, FEV1) or for blood pressure measures. The loess smoothed curves suggest very gradual trends—either a slight increase or slight decrease—without any pronounced inflection points.

Bivariate comparisons of outcomes stratified by distance and wind direction

The analysis of lung function by distance from the oil field and wind direction shows notable patterns (Table 14). At 0-0.5 miles, abnormal lung function rates were nearly identical for downwind (66.7%) and upwind (67.0%) participants. However, at 0.5-1.0 miles and 1.0-1.5 miles, downwind participants had higher rates of abnormal lung function

(66.2% and 72.3%, respectively) compared to upwind participants (55.2% and 55.6%). While these differences exist, we could not rule out chance as a contributing factor.

Average FEV1 and FVC were significantly lower among downwind participants compared to upwind individuals at 0.5-1.5 miles from the oil field. At 0.5-1.0 miles, downwind FEV1 and FVC were 2.31 and 2.64 liters, respectively, compared to 2.64 and 3.11 liters upwind (*$p < 0.05$). Similarly, at 1.0-1.5 miles, downwind FEV1 and FVC were 2.32 and 2.74 liters, compared to 2.85 and 3.25 liters upwind (*$p < 0.05$). Overall, FEV1 and FVC were consistently lower for downwind participants, indicating potential environmental effects linked to wind patterns and proximity to the oil field.

Table 14: Average FEV and FVC and abnormal lung function rates for participants among different distances and wind direction

	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 (two proportional Z test for abnormal lung function, two-sample t test for FEV1 and FVC)						

Multivariate Analysis

We performed simple regression analyses to assess the direct association between exposure and outcomes, and also multivariate analyses to assess the impact of various demographic, health, and environmental factors on respiratory outcomes, specifically FEV1 and FVC.

In the adjusted models, shown in Table 15 and Figure 10, there is no statistical mean difference in FEV1 and FVC for participants at different distances and wind directions. Modeling distance as a continuous variable (see Supplemental Table 1) similarly shows minimal variations in FEV1 and FVC with increasing distance from the IOF, further indicating that proximity to the IOF is not significantly correlated with lung function. The abnormal lung function rate is not different in all adjusted and unadjusted models.

Age was inversely related to both FEV1 and FVC, with levels decreasing by about 0.02 units with each increasing year of age, as is typical of age-related declines in lung function. Males exhibited significantly higher FEV1 (+0.92) and FVC (+1.20) than females, consistent with physiological differences. Black/African American participants displayed lower FEV1 (-0.35) and FVC (-0.40) compared to White participants, indicating potential disparities in respiratory health within this population.

Seasonal effects were observed, with both FEV1 and FVC values lower in winter (-0.24 and -0.25, respectively), suggesting possible seasonal impacts on respiratory health. However, other environmental factors such as green space and proximity to traffic were not significantly associated with lung function outcomes, implying limited influence within the range of environmental variables considered.

The analysis of wind direction effects on lung function, as shown in Table 16 and Figure 11, revealed a modest overall association between living downwind from the oil field and lung function outcomes. Specifically, individuals living downwind demonstrated a slightly higher average FVC compared to those upwind. The overall adjusted model indicated an increase of 0.21 in FVC (95% CI [0.01, 0.42]) for downwind participants, suggesting a potential positive association between downwind exposure and lung capacity. Although this finding is the opposite of what was observed in the bivariate analysis, we note that this trend was not sustained following adjustment for confounders. In other words, the distance-stratified analyses (0-0.5 miles, 0.5-1 mile, and 1-1.5 miles) showed positive but non-significant effects with confidence intervals crossing zero, leading to multivariate results that are inconsistent and not readily interpretable.

Further analysis of demographic influences highlights that age and duration of residence are linked to decreased lung function. This trend likely reflects the cumulative impact of environmental exposures over time as well as the expected declines in respiratory function with aging. We conducted a sensitivity analysis to evaluate the impact of excluding race and education from the models, given the wide confidence intervals associated with these coefficients. The analysis revealed only marginal differences in the effect estimates.

In terms of health-related factors, the results showed no statistically significant effects from smoking history, asthma diagnosis, recent cough, outdoor hours, previous COVID-19 infection, or body mass index on lung function. These variables did not substantially influence respiratory outcomes in this study population, suggesting that, at least within the context of this analysis, these health conditions and individual characteristics may have limited relevance in the presence of other environmental and demographic factors.

Environmental factors, particularly seasonal variation, also emerged as relevant. Lung function, specifically FVC, tended to be lower during the winter months, consistent with known seasonal patterns in respiratory health. This seasonal decline may reflect environmental conditions or health behaviors during colder months that impact lung function. However, proximity to traffic and levels of green space were not significantly associated with lung function outcomes.

In summary, living downwind of the oil field is associated with a slight increase in FVC overall, though this effect diminishes when analyzed across different distances. While demographic factors such as age and residence duration are consistently linked to reduced lung function, health-related factors, and environmental exposures such as traffic and green space show minimal impact. Seasonal variation in lung function, particularly in winter, remains an important environmental consideration in respiratory health analyses.

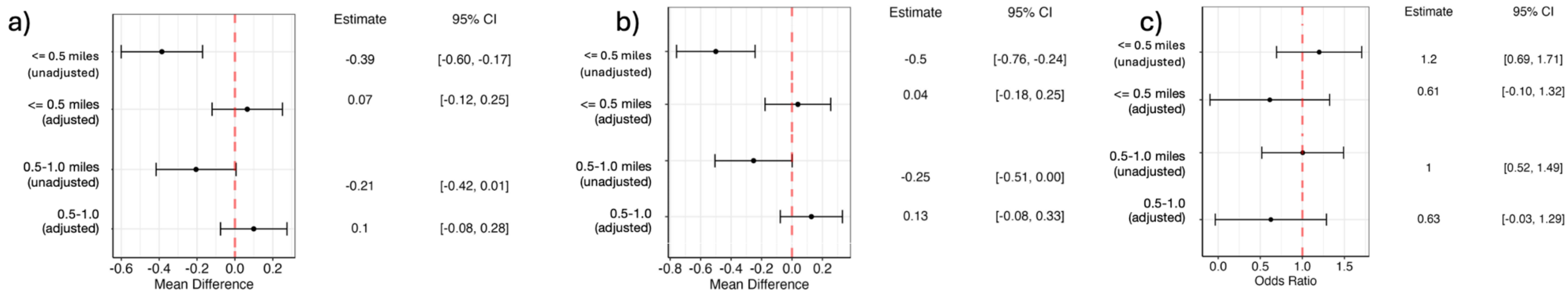


Figure 10: Mean difference of a) FEV1 b) FVC and c) odds of abnormal lung function associated with distance to the IOF. Diamonds indicate the effect estimate (mean difference or odds ratio), error bars the 95% CI, and red dashed lines the null. All comparisons are with respect to the 1-1.5 mile group. The adjusted models are adjusted for age, sex, race/ethnicity, asthma diagnosis, recent flu/cold, years living in the neighborhood, BMI, season, ever smoker, gas stove, green space and traffic

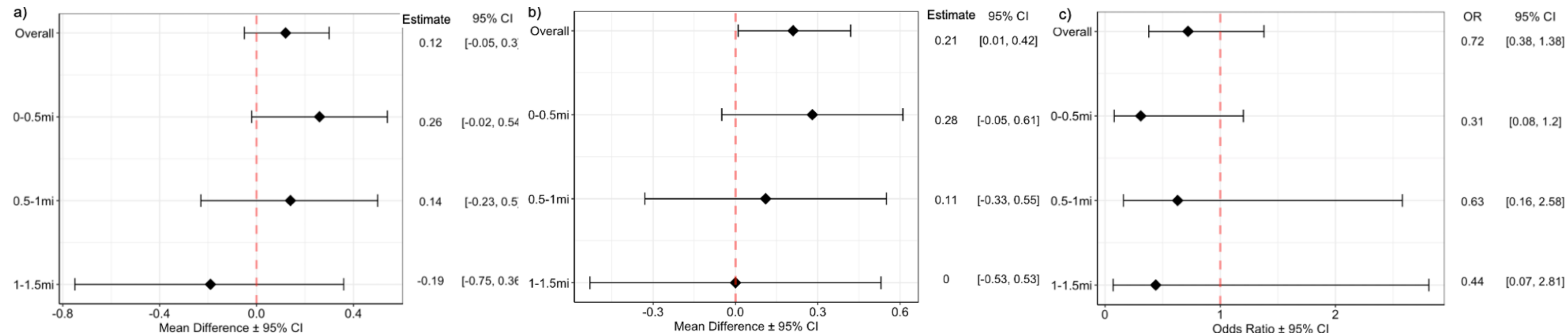


Figure 11: Mean difference in a) FEV1 b) FVC associated with wind direction within the following distance range: overall, within 0-0.5 miles, 0.5-1 miles and 1-1.5 miles. Diamonds indicate the mean difference, error bars the 95% CI, and red dashed lines the null. The models are adjusted for age, sex, race/ethnicity, asthma diagnosis, recent flu/cold, years living in the neighborhood, BMI, season, ever smoker, gas stove, ever positive for COVID-19, green space and traffic. CI = confidence interval

Table 15: Mean difference (FEV1 and FVC) and odds ratio (abnormal lung function) and 95% CI from adjusted linear regression models and logistic regression model by distance to the IOF

	Mean FEV1 (95% CI)	Mean FVC (95% CI)	Abnormal Lung Function OR (95% CI)
Intercept	3.75 [2.74, 4.76]	3.97 [2.79, 5.14]	0.02 [0.00,1.33]
Distance [ref 1-1.5 miles]			
0-0.5 miles	0.07 [-0.12, 0.25]	0.04 [-0.18, 0.25]	0.61 [0.30, 1.24]
0.5-1 miles	0.10 [-0.08, 0.28]	0.13 [-0.08, 0.33]	0.62 [0.32, 1.20]
Age	-0.02 [-0.03, -0.01]	-0.02 [-0.03, -0.02]	1.03 [1.00, 1.05]
Sex at birth [ref Female]			
Male	0.92 [0.78, 1.05]	1.20 [1.05, 1.36]	0.85 [0.52, 1.38]
Race / Ethnicity [ref White]			
Black / African American	-0.35 [-0.53, -0.17]	-0.40 [-0.61, -0.19]	7.68 [3.39, 19.56]
Asian	-0.26 [-0.46, -0.06]	-0.39 [-0.62, -0.16]	2.65 [1.31, 5.52]
Hispanic or Latinx	-0.03 [-0.28, 0.23]	-0.04 [-0.34, 0.26]	1.87 [0.76, 4.68]
Other	-0.06 [-0.26, 0.15]	-0.08 [-0.32, 0.15]	1.64 [0.80, 3.44]
Education [ref Less than high school]			
Completed college or higher	-0.15 [-1.04, 0.73]	0.16 [-0.87, 1.19]	5.26 [0.14, 211.11]
High school graduate or some college	-0.32 [-1.22, 0.58]	-0.09 [-1.13, 0.95]	7.34 [0.18, 309.10]
Smoking History [ref No]			
Yes	-0.02 [-0.18, 0.14]	0.08 [-0.11, 0.27]	1.56 [0.85, 2.92]
Diagnosed Asthma [ref No]			
Yes	0.02 [-0.14, 0.18]	0.05 [-0.14, 0.23]	0.98 [0.55, 1.75]
Cough in the past two weeks [ref No]			
Yes	-0.07 [-0.24, 0.10]	-0.10 [-0.30, 0.10]	1.62 [0.85, 3.18]
BMI	0.00 [-0.01, 0.01]	-0.00 [-0.02, 0.01]	1.01 [0.97, 1.06]
Gas Stove [ref Use Gas Stove]			
Other stove	-0.10 [-0.27, 0.06]	-0.15 [-0.34, 0.04]	1.83 [0.98, 3.47]
Within 200m Traffic [ref No]			
Yes	0.09 [-0.05, 0.23]	0.01 [-0.15, 0.17]	0.72 [0.42, 1.21]

Outdoor hours in a week	0.00 [-0.00, 0.00]	-0.00 [-0.00, 0.00]	1.00 [0.99, 1.01]
Years of Residence	-0.01 [-0.01, 0.00]	-0.01 [-0.01, 0.00]	1.02 [0.99, 1.05]
Season [ref Fall]			
Spring	-0.29 [-0.66, 0.08]	-0.38 [-0.81, 0.05]	1.29 [0.33, 5.32]
Summer	-0.06 [-0.26, 0.14]	-0.14 [-0.37, 0.10]	1.29[0.62, 2.81]
Winter	-0.24 [-0.41, -0.08]	-0.25 [-0.44, -0.07]	1.69 [0.91, 3.13]
Green Space	-0.08 [-1.03, 0.87]	-0.30 [-1.41, 0.80]	2.84 [0.08, 98.24]
COVID-19 History [ref No]			
Yes	-0.01 [-0.14, 0.13]	0.05 [-0.10, 0.21]	0.93 [0.56, 1.56]

Table 16: Mean difference (FEV1 and FVC) and odds ratio (abnormal lung function) and 95% CI from adjusted linear regression models and logistic regression model by wind direction

Variable	Mean FEV1 (95% CI)	Mean FVC (95% CI)	Abnormal Lung Function OR (95% CI)
Intercept	3.67 [2.65, 4.69]	3.84 [2.66, 5.03]	0.03 [0.00, 1.49]
Wind Direction [ref Upwind]			
Downwind	0.12 [-0.05, 0.30]	0.21 [0.00, 0.41]*	0.72 [0.37, 1.38]
Age	-0.02 [-0.03, -0.01]	-0.02 [-0.03, -0.02]	1.02 [1.00, 1.04]
Sex at birth [ref Female]			
Male	0.91 [0.78, 1.05]	1.20 [1.04, 1.35]	0.87 [0.54, 1.42]
Race / Ethnicity [ref White]			
Black / African American	-0.37 [-0.55, -0.19]	-0.45 [-0.66, -0.23]	8.14 [3.56, 20.80]
Asian	-0.25 [-0.45, -0.06]	-0.39 [-0.62, -0.16]	2.57 [1.27, 5.35]
Hispanic or Latinx	-0.05 [-0.30, 0.21]	-0.07 [-0.36, 0.23]	1.96 [0.80, 4.89]
Other	-0.06 [-0.26, 0.14]	-0.09 [-0.32, 0.15]	1.61 [0.78, 3.36]
Education [ref Less than high school]			
Completed college or higher	-0.07 [-0.96, 0.82]	0.27 [-0.76, 1.30]	3.86 [0.11, 136.89]
High school graduate or some college	-0.26 [-1.16, 0.64]	-0.01 [-1.05, 1.04]	6.02 [0.17, 224.16]
Smoking History [ref No]			
Yes	-0.02 [-0.18, 0.14]	0.08 [-0.11, 0.27]	1.59 [0.87, 2.98]
Diagnosed Asthma [ref No]			
Yes	0.02 [-0.13, 0.18]	0.05 [-0.13, 0.23]	0.97 [0.55, 1.73]
Cough in the past two weeks [ref No]			
Yes	-0.06 [-0.23, 0.11]	-0.08 [-0.28, 0.11]	1.57 [0.82, 3.09]
BMI	-0.00 [-0.01, 0.01]	-0.00 [-0.02, 0.01]	1.01 [0.97, 1.06]
Gas Stove [ref Use Gas Stove]			
Other stove	-0.08 [-0.25, 0.08]	-0.13 [-0.32, 0.06]	1.69 [0.92, 3.18]
Within 200m Traffic [ref No]			
Yes	0.06 [-0.08, 0.20]	-0.03 [-0.19, 0.13]	0.82 [0.49, 1.39]
Outdoor hours in a week	-0.00 [-0.00, 0.00]	-0.00 [-0.00, 0.00]	1.00 [0.99, 1.01]

Years of Residence	-0.01 [-0.01, 0.00]	-0.01 [-0.01, 0.00]	1.02 [0.99, 1.05]
Season [ref Fall]			
Spring	-0.32 [-0.69, 0.05]	-0.42 [-0.85, 0.01]	1.50 [0.39, 6.19]
Summer	-0.05 [-0.25, 0.15]	-0.12 [-0.36, 0.11]	1.28 [0.61, 2.69]
Winter	-0.25 [-0.41, -0.09]	-0.25 [-0.44, -0.06]	1.77 [0.97, 3.25]
Green Space	-0.43 [-1.61, 0.74]	-0.97 [-2.33, 0.39]	4.65 [0.06, 346.81]
COVID-19 History [ref No]			
Yes	0.00 [-0.14, 0.14]	0.06 [-0.10, 0.22]	0.92 [0.56, 1.54]

Supplemental Table 1. Mean difference (FEV1 and FVC) and odds ratio (abnormal lung function) and 95% CI from adjusted linear regression models and logistic regression model by distance to the IOF in miles.

Variable	Mean FEV1 (95% CI)	Mean FVC (95% CI)	Abnormal Lung function OR (95% CI)
Intercept	3.74 [2.70, 4.77]	3.93 [2.73, 5.13]	0.02 [0.00, 0.84]
Distance (miles)	0.04 [-0.14, 0.21]	0.08 [-0.12, 0.27]	1.27 [0.67, 2.44]
Age	-0.02 [-0.03, -0.01]	-0.02 [-0.03, -0.02]	1.02 [1.00, 1.05]
Sex at birth [ref Female]			
Male	0.91 [0.78, 1.05]	1.19 [1.04, 1.35]	0.85 [0.53, 1.39]
Race / Ethnicity [ref White]			
Black / African American	-0.35 [-0.53, -0.17]	-0.41 [-0.66, -0.23]	7.57 [3.34, 19.24]
Asian	-0.26 [-0.46, -0.06]	-0.39 [-0.63, -0.16]	2.69 [1.33, 5.62]
Hispanic or Latinx	-0.03 [-0.29, 0.22]	-0.05 [-0.35, 0.25]	1.88 [0.77, 4.68]
Other	-0.06 [-0.26, 0.14]	-0.09 [-0.32, 0.15]	1.66 [0.81, 3.49]
Education [ref Less than high school]			
Completed college or higher	-0.13 [-1.02, 0.76]	0.18 [-0.85, 1.21]	5.03 [0.15, 178.05]
High school graduate or some college	-0.31 [-1.21, 0.59]	-0.08 [-1.13, 0.96]	7.31 [0.21, 272.19]
Smoking History [ref No]			
Yes	-0.02 [-0.18, 0.14]	0.08 [-0.11, 0.27]	1.58 [0.86, 2.95]
Diagnosed Asthma [ref No]			
Yes	0.02 [-0.14, 0.18]	0.05 [-0.14, 0.23]	0.96 [0.55, 1.72]
Cough in the past two weeks [ref No]			
Yes	-0.07 [-0.24, 0.10]	-0.10 [-0.30, 0.10]	1.60 [0.84, 3.15]
BMI	-0.00 [-0.01, 0.01]	-0.00 [-0.02, 0.01]	1.02 [0.97, 1.06]
Gas Stove [ref Use Gas Stove]			
Other stove	-0.09 [-0.25, 0.08]	-0.13 [-0.32, 0.06]	1.76 [0.95, 3.33]
Within 200m Traffic [ref No]			
Yes	0.08 [-0.06, 0.22]	-0.03 [-0.19, 0.13]	0.75 [0.44, 1.25]
Outdoor hours in a week	-0.00 [-0.00, 0.00]	-0.00 [-0.00, 0.00]	1.00 [0.99, 1.01]
Years of Residence	-0.01 [-0.01, 0.00]	-0.01 [-0.01, 0.00]	1.02 [0.99, 1.05]

Season [ref Fall]			
Spring	-0.31 [-0.68, 0.06]	-0.42 [-0.85, 0.01]	1.36 [0.35, 5.60]
Summer	-0.06 [-0.26, 0.14]	-0.14 [-0.37, 0.10]	1.29 [0.62, 2.71]
Winter	-0.25 [-0.41, -0.09]	-0.25 [-0.44, -0.06]	1.67 [0.91, 3.09]
Green Space	0.13 [-0.79, 1.05]	-0.01 [-1.07, 1.06]	1.51 [0.05, 44.56]
COVID-19 History [ref No]			
Yes	0.00 [-0.14, 0.13]	0.06 [-0.10, 0.22]	0.93 [0.56, 1.54]

Summary and Discussion

(1) What we found

Our analysis explored the relationship between proximity to the IOF, wind direction, and lung function metrics—specifically, Forced Expiratory Volume in one second (FEV_1) and Forced Vital Capacity (FVC). Adjusted regression models revealed no significant association between residential distance from the IOF and lung function, whether distance was treated as a continuous or categorical variable. While residing downwind of the IOF was linked to higher FVC, this is inconsistent with what would be expected if oil field operations impacted lung function. Demographic factors such as age, race/ethnicity and sex exhibited expected influences on lung function, while environmental variables like proximity to traffic and green space showed no significant associations.

(2) How it compares to other studies

Our findings diverge from previous research conducted in Los Angeles, which reported reduced lung function among residents living within 200 meters of active oil drilling sites. Specifically, Johnston et al. (2021) found that individuals residing less than 200 meters from oil operations had lower lung function compared to those living farther away, after adjusting for various factors. Additionally, studies have documented adverse respiratory outcomes associated with living near oil and gas wells, including increased asthma prevalence and other health issues. The observed higher FVC levels among downwind residents contrasts with these findings, suggesting that local environmental factors or variations in exposure levels may play a role.

(3) Strengths and limitations

A notable strength of our study is the comprehensive adjustment for potential confounders, including demographic, health, and environmental variables, enhancing the robustness of our findings. However, limitations include the underrepresentation of less educated and Hispanic/Latinx residents, which may affect the generalizability of the results. Additionally, the lack of detailed information on participants' exposure to air pollutants and treatment for respiratory diseases could lead to exposure misclassification and residual confounding. The inconsistency with prior studies underscores the need for further research to elucidate the complex interactions between environmental exposures and respiratory health in urban settings.

Cardiovascular Outcomes

Overview and Descriptive Statistics

Table 17 shows blood pressure averages by proximity to IOF for 540 participants. Diastolic blood pressure (DBP) was slightly higher among participants living farther from the oil field, averaging 76.9 mmHg at 0-0.5 miles, 75.4 mmHg at 0.5-1.0 miles, and 78.1 mmHg at 1.0-1.5 miles. An ANOVA test confirmed these variations as statistically significant ($p < 0.05$). Systolic blood pressure (SBP), however, remained consistent across distances, with only slight fluctuations.

We defined high blood pressure or hypertension as SBP >130 mmHg, DBP >80 mmHg and found that 46.3% of participants within 0-0.5 miles had high blood pressure, 39.8% at 0.5-1.0 miles, and 46.9% at 1.0-1.5 miles, with no significant differences in high blood pressure rates. Note that the LA County average hypertension rate was 44.2%, although they defined high blood pressure as SBP >130 mmHg, DBP >80 mmHg or current antihypertensive use.

In summary, DBP shows minor variations by distance, but hypertension rates and SBP are stable and in line with county averages, suggesting limited correlation between IOF proximity and blood pressure in bivariate analyses.

Table 17: Average diastolic BP and systolic BP and high blood pressure rates for participants among different distances to the IOF

	0-0.5 miles (N=190)	**0.5-1.0 miles (N=211)**	**1.0-1.5 miles (N=130)**	**LA County (2015-2018)[25] ▲**
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	/

Bivariate Comparisons of Outcomes Stratified by Distance and Wind Direction

Table 18 examines blood pressure metrics and rates of high blood pressure (hypertension) by proximity to the IOF and wind direction, with comparisons between downwind and upwind residents across three distance groups.

For residents within 0-0.5 miles of the IOF, those living downwind had both a significantly higher average DBP and a higher prevalence of hypertension compared to those upwind. Specifically, the downwind group at this distance had an average DBP of 79.1 mmHg, significantly higher than the 75.8 mmHg recorded for upwind residents (*$p < 0.05$). Additionally, 56.9% of downwind residents within 0-0.5 miles were classified as having high blood pressure, compared to 40.8% of upwind residents in the same range (*$p < 0.05$).

In the 0.5-1.0 mile and 1.0-1.5 mile ranges, the differences between downwind and upwind groups were less pronounced. Average DBP varied slightly but was not significantly different, and the rates of high blood pressure were similar between downwind and upwind residents, with no statistically significant differences observed. SBP remained relatively stable across both wind direction and distance groups, showing no significant variation.

Table 18: Average diastolic BP and systolic BP and high blood pressure rates for participants among different distances and wind 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

Multivariate Analysis

In our analysis, proximity to the IOF showed no significant association with blood pressure outcomes. Neither SBP nor DBP levels varied meaningfully based on how close participants lived to the IOF, whether distance was analyzed as distinct categories (0–0.5 miles, 0.5–1 mile, and 1–1.5 miles) or as a continuous measure.

In the categorical distance analysis, both SBP and DBP were slightly lower for those living closer to the IOF compared to the reference group (1–1.5 miles), but these differences were small and not statistically significant (Figure 12 and Table 19). When distance was treated as a continuous variable, no significant trends emerged, with each additional mile from the IOF showing minimal impact on blood pressure (Supplemental Table 2)

These findings indicate that distance to the IOF was not correlated with blood pressure. In contrast, other factors, such as sex, BMI, and previous hypertension diagnosis, had stronger and statistically significant associations with blood pressure across all models.

Table 20 and Figure 13 examine the association between living downwind from the oil field and blood pressure outcomes across varying distances. Overall, SBP showed a slight, non-significant increase of +1.01 mmHg for downwind residents compared to those upwind. This pattern remained consistent across specific distance bands, such as 0-0.5 miles and 0.5-1 miles, but none of these differences reached statistical significance.

For DBP, the findings were similar. Downwind residents showed a non-significant increase of +0.6 mmHg overall, with a slightly higher difference (+2.55 mmHg) within 0-0.5 miles of the oil field. However, all DBP results remained statistically non-significant, indicating no clear impact of wind direction on DBP.

In contrast, the odds of having high blood pressure were significantly higher for downwind residents, with an overall odds ratio (OR) of 1.94, nearly double that of upwind residents, and statistically significant. Distance-specific analyses suggested that this association was particularly notable within 0-0.5 miles (OR = 2.15) and 0.5-1 miles (OR = 3.21), although confidence intervals were wider, reflecting variability in smaller sample sizes.

In summary, while systolic and diastolic pressures did not show meaningful differences based on wind direction, the increased odds of high blood pressure among downwind residents, particularly those closer to the oil field, suggest a potential health impact. These findings underscore the importance of further research to clarify the role of wind direction and proximity to oil fields on blood pressure-related health outcomes.

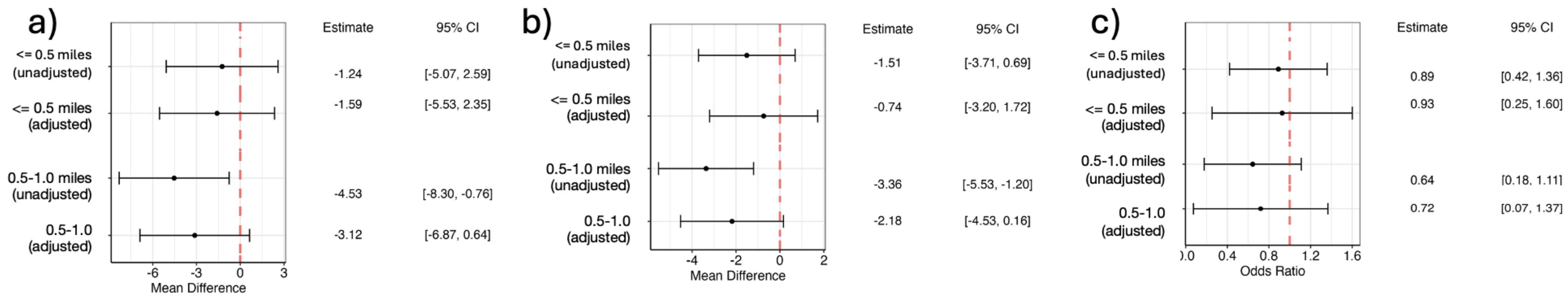


Figure 12: Mean difference of a) Systolic BP b) Diastolic BP, and odds of c) high BP associated with distance to the IOF. Diamonds indicate the effect estimates (mean differences or odds ratio), error bars the 95% CI, and red dashed lines the null. All comparisons are with respect to the 1-1.5-mile group. The adjusted models are adjusted for age, sex, race/ethnicity, hypertension diagnosis, years living in the neighborhood, BMI, season, ever smoker, gas stove, green space, and traffic. CI = confidence interval

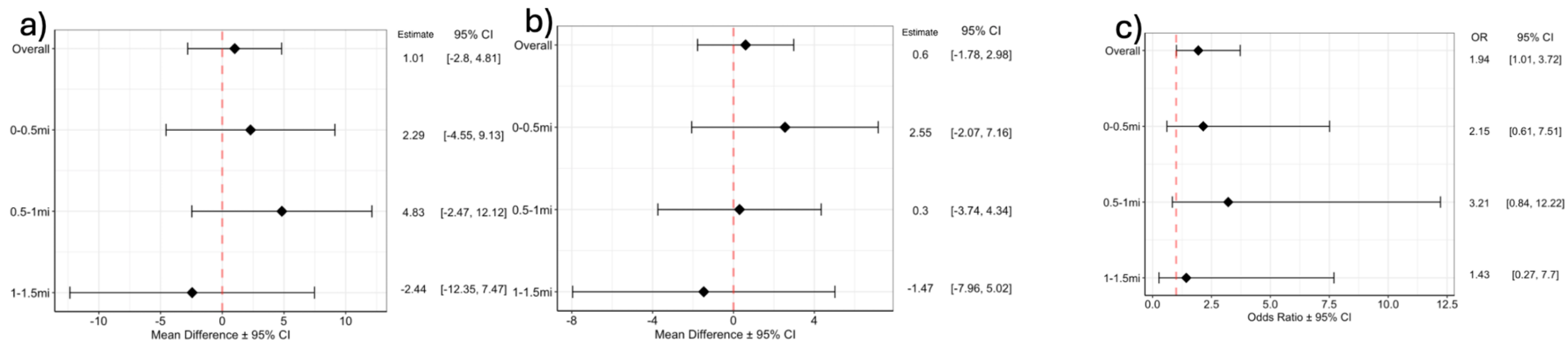


Figure 13: Mean difference of a) Systolic BP b) Diastolic BP, and odds of c) high BP rate among downwind vs. upwind residents within the following distance range: overall, within 0-0.5 miles, 0.5-1 miles and 1-1.5 miles. Diamonds indicate the effect estimate (mean difference/ odds ratio), error bars the 95% CI, and red dashed lines the null. The adjusted models are adjusted for age, sex, race/ethnicity, hypertension diagnosis, years living in the neighborhood, BMI, season, ever smoker, gas stove, green space, and traffic. CI = confidence interval.

Table 19: Mean difference (systolic and diastolic BP) and odds ratio (high BP) and 95% CI from adjusted linear regression models and logistic regression model by distance to the IOF

Variable	Mean Systolic BP (95% CI)	Mean Diastolic BP (95% CI)	High BP OR (95% CI)
Intercept	84.13 [74.52, 93.73]	60.41 [54.41, 66.42]	0.01 [0.00, 0.03]
Distance [ref 1-1.5 miles]			
0-0.5 miles	-1.65 [-5.59, 2.29]	-0.69 [-3.15, 1.77]	0.93 [0.47, 1.82]
0.5-1 miles	-3.12 [-6.87, 0.64]	-2.18 [-4.53, 0.16]	0.73 [0.39, 1.39]
Age	0.17 [0.05, 0.30]	-0.02 [-0.10, 0.06]	1.01 [0.98, 1.03]
Sex at birth [ref Female]			
Male	11.54 [8.75, 14.34]	2.74 [0.99, 4.48]	2.40 [1.49, 3.88]
Race / Ethnicity [ref White]			
Black / African American	4.29 [0.47, 8.11]	-0.36 [-2.75, 2.03]	1.19 [0.61, 2.31]
Asian	2.35 [-1.89, 6.59]	1.90 [-0.74, 4.55]	1.79 [0.86, 3.68]
Hispanic or Latinx	0.84 [-4.46, 6.14]	-2.38 [-5.69, 0.93]	1.26 [0.49, 3.13]
Other	0.52 [-3.82, 4.86]	-0.71 [-3.43, 2.00]	0.85 [0.39, 1.81]
Education [ref Less than college]			
College or higher	2.79 [-1.20, 6.77]	3.05 [0.56, 5.54]*	1.35 [0.68, 2.73]
Smoking History [ref No]			
Yes	-0.21 [-3.67, 3.25]	-1.76 [-3.92, 0.40]	0.81 [0.44, 1.46]
BMI	0.61 [0.37, 0.86]	0.53 [0.38, 0.69]	1.15 [1.10, 1.21]
Gas Stove [ref Use Gas Stove]			
Other stove	-0.61 [-4.12, 2.90]	-1.02 [-3.22, 1.17]	1.00 [0.55, 1.82]
Within 200m Traffic [ref No]			
Yes	1.07 [-1.90, 4.03]	-0.36 [-2.21, 1.49]	0.84 [0.50, 1.39]
Outdoor hours in a week	0.03 [-0.02, 0.09]	0.02 [-0.01, 0.05]	1.00 [0.99, 1.01]
Years of Residence	0.03 [-0.12, 0.17]	-0.05 [-0.14, 0.04]	1.00 [0.98, 1.03]
Green Space	-5.18 [-24.96, 14.61]	-1.56 [-13.92, 10.80]	2.18 [0.07, 67.99]
Previous Diagnosis of High BP			
Yes	9.89 [6.53, 13.24]	4.41 [2.31, 6.51]	2.84 [1.63, 5.03]

Table 20: Mean difference (systolic and diastolic BP) and odds ratio (high BP) and 95% CI from adjusted linear regression models and logistic regression model by wind direction

Variable	Mean Systolic BP (95% CI)	Mean Diastolic BP (95% CI)	High BP OR (95% CI)
Intercept	82.36 [72.77, 91.96]	59.07 [53.06, 65.07]	0.004 [0.001, 0.021]
Wind Direction [ref Upwind]			
Downwind	1.01 [-2.80, 4.81]	0.60 [-1.78, 2.98]	1.94 [1.01, 3.75]*
Age	0.17 [0.05, 0.29]*	-0.02 [-0.10, 0.06]	1.01 [0.99, 1.03]
Sex at birth [ref Female]			
Male	11.64 [8.85, 14.44]	2.80 [1.05, 4.55]	2.42 [1.50, 3.93]
Race / Ethnicity [ref White]			
Black / African American	4.06 [0.13, 8.00]*	-0.48 [-2.94, 1.98]	1.01 [0.51, 2.00]
Asian	2.61 [-1.63, 6.85]	2.12 [-0.53, 4.78]	1.88 [0.91, 3.87]
Hispanic or Latinx	0.90 [-4.43, 6.23]	-2.35 [-5.68, 0.99]	1.14 [0.43, 2.89]
Other	0.61 [-3.74, 4.96]	-0.62 [-3.34, 2.10]	0.85 [0.39, 1.82]
Education [ref Less than college]			
College or higher	2.73 [-1.25, 6.71]	3.07 [0.58, 5.56]*	1.47 [0.75, 2.97]
Smoking History [ref No]			
Yes	-0.21 [-3.67, 3.25]	-1.79 [-3.95, 0.38]	0.80 [0.44, 1.44]
BMI	0.62 [0.37, 0.87]	0.54 [0.39, 0.69]	1.15 [1.10, 1.21]
Gas Stove [ref Use Gas Stove]			
Other stove	-0.83 [-4.33, 2.66]	-1.14 [-3.33, 1.05]	1.04 [0.57, 1.88]
Within 200m Traffic [ref No]			
Yes	1.00 [-2.00, 3.99]	-0.47 [-2.34, 1.41]	0.75 [0.44, 1.25]
Outdoor hours in a week	0.03 [-0.02, 0.09]	0.02 [-0.01, 0.05]	1.00 [0.99, 1.01]
Years of Residence	0.03 [-0.12, 0.18]	-0.05 [-0.14, 0.04]	1.00 [0.97, 1.03]
Green Space	-14.79 [-39.60, 10.01]	-7.92 [-23.45, 7.60]	0.08 [0.001, 5.68]
Previous Diagnosis of High BP			
Yes	10.04 [6.68, 13.39]	4.47 [2.37, 6.57]	2.97 [1.69, 5.26]

Supplemental Table 2: Mean difference (systolic and diastolic BP) and odds ratio (high BP) and 95% CI from adjusted linear regression models and logistic regression model by distance to the IOF in miles

Variable	Mean Systolic BP (95% CI)	Mean Diastolic BP (95% CI)	High BP OR (95% CI)
Intercept	81.77 [71.24, 92.30]	58.89 [52.30, 65.48]	0.0039 [0.0005, 0.0268]
Distance in miles			
Miles	0.79 [-2.85, 4.43]	0.34 [-1.94, 2.61]	1.17 [0.62, 2.19]
Age	0.17 [0.05, 0.29]	-0.02 [-0.10, 0.06]	1.01 [0.99, 1.03]
Sex at birth [ref Female]			
Male	11.61 [8.80, 14.41]	2.78 [1.03, 4.54]	2.39 [1.49, 3.88]
Race / Ethnicity [ref White]			
Black / African American	4.29 [0.45, 8.12]	-0.34 [-2.74, 2.05]	1.19 [0.61, 2.30]
Asian	2.62 [-1.63, 6.86]	2.12 [-0.54, 4.77]	1.85 [0.89, 3.80]
Hispanic or Latinx	0.96 [-4.36, 6.27]	-2.30 [-5.63, 1.03]	1.24 [0.48, 3.10]
Other	0.65 [-3.70, 5.00]	-0.60 [-3.33, 2.12]	0.86 [0.40, 1.84]
Education [ref Less than college]			
College or higher	2.70 [-1.28, 6.68]	3.03 [0.54, 5.53]*	1.37 [0.70, 2.76]
Smoking History [ref No]			
Yes	-0.23 [-3.69, 3.23]	-1.80 [-3.96, 0.37]	0.80 [0.43, 1.44]
BMI	0.63 [0.38, 0.87]	0.54 [0.39, 0.70]	1.15 [1.10, 1.22]
Gas Stove [ref Use Gas Stove]			
Other stove	-0.80 [-4.31, 2.71]	-1.14 [-3.34, 1.06]	1.01 [0.55, 1.83]
Within 200m Traffic [ref No]			
Yes	1.07 [-1.89, 4.03]	-0.40 [-2.26, 1.45]	0.82 [0.49, 1.36]
Outdoor hours in a week	0.03 [-0.02, 0.09]	0.02 [-0.01, 0.05]	1.00 [0.99, 1.01]
Years of Residence	0.03 [-0.12, 0.18]	-0.05 [-0.14, 0.05]	1.00 [0.98, 1.03]
Green Space	-9.86 [-28.87, 9.14]	-5.08 [-16.98, 6.82]	1.48 [0.05, 39.73]
Previous Diagnosis of High BP			
Yes	9.93 [6.57, 13.29]	4.42 [2.31, 6.52]	2.82 [1.61, 4.97]

Summary and Discussion

(1) What we found

Our study examined the association between proximity to the IOF and blood pressure outcomes among local residents, incorporating factors such as wind direction to explore the potential health impact of living near the IOF. Descriptive analyses in Table 17 indicated a slight but statistically significantly higher average DBP level with distance from the IOF. However, SBP remained stable across distances, and hypertension rates aligned with county averages, suggesting limited impact of IOF proximity on these metrics.

In contrast, the association between wind direction and blood pressure outcomes was more pronounced, particularly for residents within 0-0.5 miles of the IOF. As seen in Table 18 and Figure 4, downwind residents in this range had significantly higher DBP and a higher prevalence of hypertension compared to those upwind, with 56.9% of downwind residents classified as hypertensive versus 40.8% upwind. In multivariate regression analysis, proximity to the IOF was not significantly associated with blood pressure outcomes, and wind direction's effect on DBP and SBP was similarly limited, though the odds of high blood pressure (OR = 1.94) were higher for downwind residents overall. This effect was most substantial within 0-0.5 miles, with ORs of 2.15 and 3.21 in distance-specific analyses.

(2) How it compares to other studies

Our findings align partially with previous research suggesting potential health impacts of living near oil extraction sites, though specific blood pressure trends remain inconsistent. Johnston et al. (2023), in a study on the health effects of proximity to oil and gas extraction sites in California, found DBP and SBP drop significantly for every 100-meter increase in distance from the OGD site. This supports our finding of higher odds of hypertension for downwind residents, especially those closest to the IOF, though we did not observe significant increases in SBP or DBP. Similarly, McKenzie et al. (2019) reported associations between high versus low O&G activity exposure and higher SBP and DBP among participants not taking prescription medications.

In summary, our study adds to a small but growing body of evidence linking proximity to oil fields with hypertension. However, the lack of clear systolic or diastolic pressure elevations in our study, indicate a need for more research that can address some of the limitations of the current analysis such as a lack of personal measures of exposure, repeated measures, or information on treatment for hypertension.

(3) Strengths and limitations

A major strength of this study is the inclusion of wind direction as a variable, allowing us to capture potential exposure differences among downwind and upwind residents.

Additionally, we controlled for key demographic and health factors, which helped isolate the effects of proximity and direction relative to the IOF. However, several limitations should be noted. Our analysis lacked specific information on individual treatments for hypertension, which may affect our interpretation of blood pressure measurements. Moreover, the study had an underrepresentation of certain demographic groups, particularly those with lower educational attainment and Hispanic or Latinx residents, potentially limiting generalizability. Finally, the cross-sectional design restricted our ability to draw causal inferences, and small sample sizes in distance-stratified analyses may have reduced the precision of our findings. Further research should aim to incorporate longitudinal designs and larger sample sizes to confirm these results and explore the health impacts of oil fields more comprehensively.

Other Outcomes from the Survey

Overview and Descriptive Statistics

In our study, we examined various self-reported health conditions, recent symptoms, and perceived noise exposure among 588 participants residing at different distances from the IOF. Specifically, we gathered data on diagnosed health conditions (e.g., high cholesterol, cancer, heart disease), recent symptoms experienced in the past two weeks (e.g., sore throat, headache, cough), and community noise sources (e.g., from traffic, airplanes, oil field operations).

Overall, we analyzed 6 self-reported diseases and 20 recent symptoms in Table 21 and Table 22. The most commonly reported health condition across the community was high cholesterol (reported by 41.7% of participants), with prevalence notably higher among those living closer to the IOF. Cancer was also reported more frequently by participants residing within 0.5 miles of the IOF (21.1%) compared to those further away (6% at 1-1.5 miles), showing a significant trend with distance ($p < 0.001$). Figure 14 illustrates that the prevalence of high cholesterol was notably higher than the LA County average[26] (represented by the blue line), based on data from 2007-2014. Similarly, cancer prevalence was markedly higher among participants above the LA County average reported in 2017[27]. Due to smaller sample sizes in specific distance categories (0.5-1.5 miles) and concerns about model stability, we collapsed cases in the 0.5-1.5 mile range into a single category for subsequent analyses.

For symptoms, the most commonly reported were headache (50.5% of participants) and fatigue (60%), both of which were more frequent among individuals closer to the oil field. Notably, sore throat ($p = 0.027$) and headache ($p = 0.001$) showed statistically significant differences across distances, with higher rates nearer to the IOF.

Regarding noise, participants closer to the IOF reported higher levels of noise from traffic and oil field operations (Supplemental Table 3). Specifically, 23.4% of residents within 0.5 miles reported experiencing a "great deal" of noise from traffic, compared to 6.7% of those 1-1.5 miles away. Noise from oil field operations was also perceived more frequently among those closest to the field, with 5.3% of participants within 0.5 miles reporting a "great deal" of noise from this source, compared to 0.7% in the 1-1.5 mile range.

Building on these findings, we further investigated the relationship between proximity to the IOF and specific symptoms such as sore throat and headache, given their statistically significant differences by distance in the bivariate analysis. These symptoms were examined using multivariate regression to adjust for potential confounders. Additionally, we performed multivariate regression analyses on high cholesterol and self-reported cancer of all types.

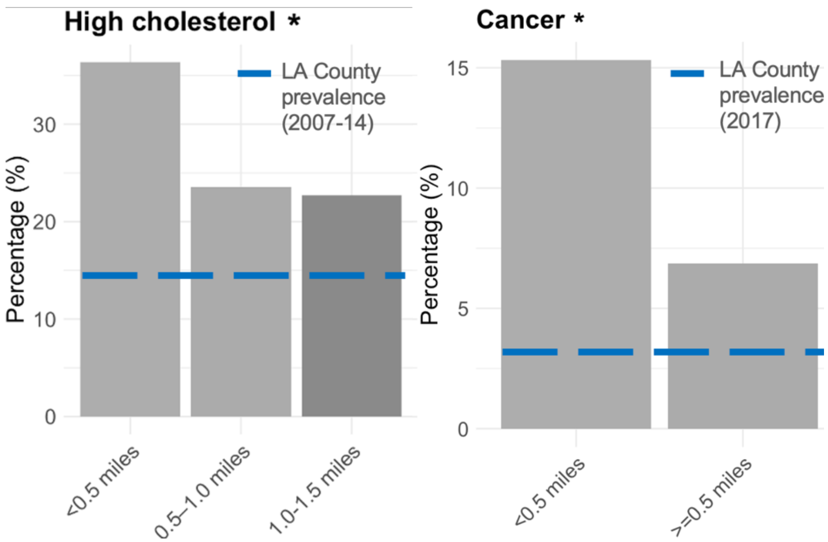


Figure 14: Bar plots for self-reported high cholesterol and cancer (all types) near IOF vs LA county prevalence[26,27]. Reports of cancer >= 0.5 miles are merged together due to small number of cases

Table 21: Self-reported diseases previously diagnosed for participant or household member

	<0.5 miles (N=209)	0.5–1.0 miles (N=229)	1.0-1.5 miles (N=150)	Overall (N=588)	p-value
Has a doctor or other health professional ever told you that you or another household member have a heart problem, such as coronary heart disease, angina, or had a heart attack?					0.062
No	173 (82.8%)	203 (88.6%)	136 (90.7%)	512 (87.1%)	
Yes	32 (15.3%)	25 (10.9%)	11 (7.3%)	68 (11.6%)	
Missing	4 (1.9%)	1 (0.4%)	3 (2.0%)	8 (1.4%)	
Has a doctor or health professional ever told you that you had high cholesterol?					0.002
No	97 (46.4%)	136 (59.4%)	97 (64.7%)	330 (56.1%)	
Yes	106 (50.7%)	87 (38.0%)	52 (34.7%)	245 (41.7%)	
Missing	6 (2.9%)	6 (2.6%)	1 (0.7%)	13 (2.2%)	
Have you ever been told by a doctor or health professional that you had cancer?					<0.001
No	164 (78.5%)	197 (86.0%)	139 (92.7%)	500 (85.0%)	
Yes	44 (21.1%)	31 (13.5%)	9 (6.0%)	84 (14.3%)	
Missing	1 (0.5%)	1 (0.4%)	2 (1.3%)	4 (0.7%)	
Do you or anyone in your household have the following respiratory condition: Allergies					0.781
No	80 (38.3%)	86 (37.6%)	53 (35.3%)	219 (37.2%)	
Yes	117 (56.0%)	132 (57.6%)	91 (60.7%)	340 (57.8%)	
Missing	12 (5.7%)	11 (4.8%)	6 (4.0%)	29 (4.9%)	
Chronic Obstructive Pulmonary Disease					0.217
No	193 (92.3%)	222 (96.9%)	143 (95.3%)	558 (94.9%)	
Yes	8 (3.8%)	3 (1.3%)	3 (2.0%)	14 (2.4%)	
Missing	8 (3.8%)	4 (1.7%)	4 (2.7%)	16 (2.7%)	
Chronic Bronchitis					
No	195 (93.3%)	208 (90.8%)	139 (92.7%)	542 (92.2%)	0.547
Yes	8 (3.8%)	14 (6.1%)	7 (4.7%)	29 (4.9%)	
Missing	6 (2.9%)	7 (3.1%)	4 (2.7%)	17 (2.9%)	
Pneumonia					0.419
No	196 (93.8%)	219 (95.6%)	141 (94.0%)	556 (94.6%)	
Yes	10 (4.8%)	6 (2.6%)	7 (4.7%)	23 (3.9%)	
Missing	3 (1.4%)	4 (1.7%)	2 (1.3%)	9 (1.5%)	

Note: p-values were calculated using chi-square test and fisher exact test for small counts.

Table 22: Self-reported symptoms experienced in the past 2 weeks

	<0.5 miles (N=209)	0.5–1.0 miles (N=229)	1.0-1.5 miles (N=150)	Overall (N=588)	p-value
Thinking about your health in the past 2 weeks, have you experienced any of the following symptoms:					
Frequent or chronic cough	55 (26.3%)	63 (27.5%)	39 (26.0%)	157 (26.7%)	0.944
Sore throat	41 (19.6%)	63 (27.5%)	47 (31.3%)	151 (25.7%)	0.027
Hay fever	48 (23%)	61 (26.6%)	36 (24%)	145 (24.7%)	0.748
Nausea	35 (16.7%)	40 (17.5%)	35 (23.3%)	110 (18.7%)	0.222
Vomiting	5 (2.4%)	9 (3.9%)	10 (6.7%)	24 (4.1%)	0.058
Rashes	31 (14.8%)	26 (11.4%)	30 (20%)	87 (14.8%)	0.065
Headache	89 (42.6%)	115 (50.2%)	93 (62%)	297 (50.5%)	0.001
Nose bleeds	8 (3.8%)	16 (7.0%)	13 (8.7%)	37 (6.3%)	0.154
Wheezing/whistling in the chest	27 (12.9%)	32 (14.0%)	25 (16.7%)	84 (14.3%)	0.637
Sleep disturbance by wheeze	20 (9.6%)	21 (9.2%)	18 (12.0%)	59 (10.0%)	0.633
Morning cough every day	48 (23.0%)	58 (25.3%)	46 (30.7%)	152 (25.9%)	0.281
Sneezing or runny nose	122 (58.4%)	140 (61.1%)	100 (66.7%)	362 (61.6%)	0.304
Tightness in the chest	34 (16.3%)	40 (17.5%)	25 (16.7%)	99 (16.8%)	0.943
Irritation of the eyes/watery eyes	99 (47.4%)	120 (52.4%)	84 (56.0%)	303 (51.5%)	0.218
Irritation of the nose	78 (37.3%)	96 (41.9%)	67 (44.7%)	241 (41%)	0.349
Dizziness	42 (20.1%)	47 (20.5%)	30 (20.0%)	119 (20.2%)	0.99
Fatigue	119 (56.9%)	137 (59.8%)	97 (64.7%)	353 (60%)	0.323
Diarrhea	33 (15.8%)	43 (18.8%)	38 (25.3%)	114 (19.4%)	0.068
Ringing of the ears	53 (25.4%)	71 (31.0%)	50 (33.3%)	174 (29.6%)	0.229
Backache	90 (43.1%)	112 (49.0%)	76 (50.7%)	278 (47.3%)	0.305
Seizure	0 (0%)	1 (0.4%)	0 (0%)	1 (0.2%)	1
Trouble hearing	47 (22.5%)	42 (18.3%)	28 (18.7%)	117 (19.9%)	0.533
Shortness of breath after exercise	54 (25.8%)	62 (27.1%)	46 (30.7%)	162 (27.6%)	0.648

Note: p-values were calculated using chi-square test and fisher exact test for small counts.

Supplemental Table 3: Noise Experienced in the Community by Distance from IOF

	<0.5 miles (N=209)	0.5–1.0 miles (N=229)	1.0-1.5 miles (N=150)	Overall (N=588)	p-value
Noise from cars and trucks					0.001
A great deal	49 (23.4%)	71 (31.0%)	45 (30.0%)	165 (28.1%)	
Somewhat	62 (29.7%)	76 (33.2%)	64 (42.7%)	202 (34.4%)	
Only a little	56 (26.8%)	60 (26.2%)	30 (20.0%)	146 (24.8%)	
Not at all	38 (18.2%)	19 (8.3%)	10 (6.7%)	67 (11.4%)	
Missing	4 (1.9%)	3 (1.3%)	1 (0.7%)	8 (1.4%)	
Noise from airplanes					0.907
A great deal	25 (12.0%)	27 (11.8%)	15 (10.0%)	67 (11.4%)	
Somewhat	55 (26.3%)	66 (28.8%)	49 (32.7%)	170 (28.9%)	
Only a little	67 (32.1%)	74 (32.3%)	45 (30.0%)	186 (31.6%)	
Not at all	61 (29.2%)	60 (26.2%)	40 (26.7%)	161 (27.4%)	
Missing	1 (0.5%)	2 (0.9%)	1 (0.7%)	4 (0.7%)	
Noise from oil field operations near your home					<0.001
A great deal	11 (5.3%)	2 (0.9%)	1 (0.7%)	14 (2.4%)	
Somewhat	19 (9.1%)	15 (6.6%)	9 (6.0%)	43 (7.3%)	
Only a little	35 (16.7%)	22 (9.6%)	11 (7.3%)	68 (11.6%)	
Not at all	133 (63.6%)	174 (76.0%)	115 (76.7%)	422 (71.8%)	
Missing	11 (5.3%)	16 (7.0%)	14 (9.4%)	41 (7.0%)	
Noise from construction					0.103
A great deal	24 (11.5%)	29 (12.7%)	20 (13.3%)	73 (12.4%)	
Somewhat	51 (24.4%)	57 (24.9%)	50 (33.3%)	158 (26.9%)	
Only a little	75 (35.9%)	71 (31.0%)	53 (35.3%)	199 (33.8%)	
Not at all	55 (26.3%)	68 (29.7%)	25 (16.7%)	148 (25.2%)	
Missing	4 (1.9%)	4 (1.7%)	2 (1.4%)	10 (1.7%)	

Note: p-values were calculated using chi-square test and fisher exact test for small counts.

Bivariate Comparisons of Outcomes Stratified by Distance and Wind Direction

The analysis indicated no significant impact of wind direction on the prevalence of the symptoms or conditions tested (sore throat, headache, high cholesterol, and cancer) across the different distance categories. For each symptom or condition, the proportions between downwind and upwind residents were similar, and none of the comparisons yielded statistically significant differences across distances except for cancer when comparing wind direction for those living 0.5-1.5 miles from the oil field as a whole.

Table 23: Self-reported sore throat/headache/high cholesterol/cancer for participants among different distances and wind direction

	<0.5 miles (N=181)		**0.5–1.0 miles (N=199)**		**1.0-1.5 miles (N=116)**	
	Downwind (N=63)	Upwind (N=118)	Downwind (N=139)	Upwind (N=60)	Downwind (N=48)	Upwind (N=68)
Sore Throat	17.4%	22.0%	24.5%	31.7%	31.3%	30.9%
Headache	41.3%	46.6%	46.0%	56.7%	64.6%	58.8%
High Cholesterol	49.2%	50.0%	38.8%	40.0%	39.6%	35.3%
Cancer (< 0.5 and >=0.5)	14.3%	20.3%	17.3% (Downwind in 0.5-1.5)	6.7%* (Upwind in 0.5-1.5)		

Multivariate Analysis

Our analysis of high cholesterol and cancer prevalence showed distinct trends when examining distance and wind direction relative to the Inglewood Oil Field (Table 24). Participants living closer to the oil field (<0.5 miles) had slightly higher odds of high cholesterol compared to those further away, although these findings were not statistically significant, suggesting only a minimal distance-based effect. In contrast, when considering wind direction, there was no significant difference in high cholesterol odds between downwind and upwind residents, with an odds ratio of 0.91, which suggests similar rates regardless of wind exposure.

For cancer prevalence, distance to the oil field also did not show a significant association. However, those living downwind had slightly higher odds of reporting cancer compared to upwind residents (OR = 1.24), though this increase was not statistically significant. The results indicated that neither proximity nor wind direction strongly impacted self-reported cancer rates in this sample, but slight directional differences warrant further examination.

In our analysis of self-reported symptoms, we found that neither sore throat nor headache showed a statistically significant association with either distance from IOF or wind direction (Table 25). When examining distance, residents within 0–0.5 miles and 0.5–1 mile of the IOF had similar odds of reporting sore throat and headache symptoms compared to those living 1–1.5 miles away. Specifically, for sore throat, the odds ratios were 0.68 and 1.02 for 0–0.5 miles and 0.5–1 mile, respectively, neither of which reached statistical significance. Similarly, for headache, the odds ratios were 0.63 and 0.65 for these distances, indicating no notable trend.

When looking at wind direction, residents downwind of the IOF had slightly higher odds of reporting sore throat (OR = 1.12) and headache (OR = 1.13) than those upwind, though these findings were not statistically significant. This suggests that neither proximity to the IOF nor prevailing wind direction had a clear impact on the likelihood of experiencing sore throat or headache in this community.

Table 24: Odds ratio and 95% CI from adjusted logistic regression models of self-reported conditions by distance to the IOF and wind direction

	Distance		Wind Direction	
Variables	**High Cholesterol OR (95% CI)**	**Cancer OR (95% CI)**	**High Cholesterol OR (95% CI)**	**Cancer OR (95% CI)**
Intercept	0.03 (0.006, 0.17)	0.002 (0.0001, 0.041)	0.03 (0.006, 0.16)	0.002 (0.00008, 0.03)
Exposure				
Distance: 0.5–1.0 miles [ref 1-1.5 mi]	1.37 (0.71, 2.66)	-	-	-
Distance: 1.0–1.5 miles [ref 1-1.5 mi]	0.94 (0.50, 1.79)	-	-	-
Less than 0.5 miles [ref 0.5-1.5 mi]	-	1.67 (0.80, 3.52)	-	-
Downwind [ref: Upwind]	-	-	0.91 (0.56, 1.48)	1.24 (0.57, 2.73)
Age	1.02 (1.00, 1.04)	1.07 (1.04, 1.12)	1.02 (1.00, 1.04)	1.08 (1.04, 1.12)
Sex at Birth [ref: Female]				
Male	1.17 (0.73, 1.88)	0.57 (0.24, 1.27)	1.16 (0.72, 1.86)	0.57 (0.24, 1.25)
Race / Ethnicity [ref: White]				
Black / African American	1.07 (0.55, 2.02)	0.51 (0.19, 1.25)	1.11 (0.57, 2.14)	0.48 (0.18, 1.21)
Other	1.69 (0.99, 2.89)	0.59 (0.21, 1.52)	1.71 (1.00, 2.93)	0.60 (0.21, 1.54)
Education [ref: Less than College]				
Completed College or Higher	1.83 (0.91, 3.90)	0.81 (0.32, 2.22)	1.93 (0.97, 4.09)	0.96 (0.39, 2.59)
Smoking History [ref: No]				
Yes	0.68 (0.36, 1.23)	0.54 (0.21, 1.29)	0.66 (0.36, 1.20)	0.53 (0.20, 1.24)
BMI	1.01 (0.97, 1.05)	1.01 (0.95, 1.07)	1.01 (0.98, 1.05)	1.01 (0.95, 1.07)
Gas Stove [ref: Gas Stove Use]				
Other Stove	0.84 (0.45, 1.52)	0.26 (0.07, 0.78)	0.87 (0.47, 1.55)	0.29 (0.08, 0.86)
Within 200m Traffic [ref: No]				
Yes	0.83 (0.49, 1.40)	0.97 (0.41, 2.19)	0.81 (0.48, 1.35)	0.85 (0.36, 1.91)
Outdoor Hours in a Week	1.00 (0.99, 1.01)	1.00 (0.98, 1.01)	1.00 (0.99, 1.01)	1.00 (0.98, 1.01)
Year of Residence	1.02 (0.99, 1.04)	1.01 (0.97, 1.04)	1.02 (0.99, 1.04)	1.01 (0.98, 1.04)

Table 25: Odds ratio and 95% CI from adjusted logistic regression models of self-reported symptoms by distance to the IOF and wind direction

	Sore throat OR (95% CI)	Headache OR (95% CI)	Sore throat OR (95% CI)	Headache OR (95% CI)
Intercept	1.09 [0.21, 5.68]	5.66 [1.22, 26.98]	1.08 [0.21, 5.70]	4.52 [0.98, 21.34]
Exposure				
Distance: 0.5–1.0 miles [ref 1-1.5 mi]	0.68 [0.33, 1.40]	0.63 [0.33, 1.20]	-	-
Distance: 1.0–1.5 miles [ref 1-1.5 mi]	1.02 [0.53, 1.97]	0.65 [0.35, 1.19]	-	-
Downwind [ref: Upwind]	-	-	1.12 [0.57, 2.21]	1.13 [0.61, 2.11]
Age	0.97 [0.95, 0.99]	0.98 [0.96, 0.99]	0.97 [0.95, 0.99]	0.97 [0.95, 0.99]
Sex at birth [ref Female]				
Male	0.57 [0.33, 0.95]	0.39 [0.24, 0.61]	0.57 [0.34, 0.96]	0.40 [0.25, 0.63]
Race / Ethnicity [ref White]				
Black / African American	0.44 [0.19, 0.93]	0.66 [0.35, 1.22]	0.43 [0.19, 0.92]	0.63 [0.33, 1.20]
Asian	0.83 [0.38, 1.74]	0.55 [0.27, 1.08]	0.81 [0.37, 1.69]	0.55 [0.28, 1.08]
Hispanic or Latinx	0.60 [0.22, 1.52]	0.48 [0.20, 1.15]	0.60 [0.22, 1.51]	0.49 [0.20, 1.17]
Other	1.09 [0.51, 2.26]	0.46 [0.22, 0.94]	1.08 [0.51, 2.24]	0.46 [0.22, 0.94]
Education [ref Less than college]				
Completed college or higher	0.54 [0.27, 1.10]	0.69 [0.36, 1.32]	0.53 [0.27, 1.06]	0.67 [0.35, 1.26]
Smoking History [ref: No]				
Yes	0.85 [0.44, 1.60]	0.89 [0.51, 1.54]	0.87 [0.45, 1.64]	0.90 [0.52, 1.56]
Diagnosed Asthma [ref No]				
Yes	1.17 [0.64, 2.08]	1.45 [0.84, 2.53]	1.18 [0.65, 2.09]	1.45 [0.84, 2.53]
BMI	1.05 [1.01, 1.09]	1.04 [1.00, 1.08]	1.05 [1.00, 1.09]	1.04 [1.00, 1.08]
Gas Stove [ref Use Gas Stove]				
Other stove	1.07 [0.56, 2.01]	0.94 [0.53, 1.65]	1.02 [0.53, 1.90]	0.89 [0.51, 1.56]
Within 200m Traffic [ref No]				
Yes	0.67 [0.38, 1.16]	1.29 [0.80, 2.10]	0.70 [0.39, 1.21]	1.33 [0.82, 2.17]

Outdoor hours in a week	1.01 [1.00, 1.02]	1.00 [0.99, 1.01]	1.01 [1.00, 1.02]	1.00 [0.99, 1.01]
Year of Residence	0.99 [0.96, 1.02]	0.98 [0.96, 1.01]	0.99 [0.96, 1.02]	0.98 [0.96, 1.01]
Season [ref Fall]				
Spring	1.24 [0.30, 4.47]	0.73 [0.20, 2.62]	1.31 [0.31, 4.71]	0.79 [0.22, 2.78]
Summer	0.96 [0.43, 2.12]	0.98 [0.49, 1.96]	1.01 [0.45, 2.22]	1.00 [0.50, 2.00]
Winter	0.78 [0.42, 1.49]	1.10 [0.63, 1.91]	0.86 [0.47, 1.60]	1.12 [0.65, 1.95]
Green Space	0.54 [0.01, 19.62]	0.21 [0.01, 5.25]	0.30 [0.00, 26.95]	0.06 [0.00, 3.31]

Summary and Discussion

(1) What we found

Our study aimed to explore the relationship between proximity to the IOF, wind direction, and various self-reported health conditions and symptoms among local residents. We assessed recent symptoms and diagnosed conditions among 588 participants living at varying distances from the IOF. Key findings indicated higher reported rates of certain conditions, such as high cholesterol and cancer, among residents closer to the IOF, although these associations were not statistically significant in multivariate models. Similarly, symptoms like sore throat and headache, which initially showed distance-related patterns in bivariate analyses, did not retain significant associations with distance or wind direction in multivariate regression that controlled other covariates. Noise exposure from traffic and oil field operations were more frequently reported by those living closer to the IOF.

(2) How it compares to other studies

Our findings aligned with previous research suggesting potential health impacts of living near oil and gas operations, although no direct causal relationship has been established. Prior studies from Colorado and Texas have documented associations between residential proximity to oil and gas sites and increased rates of respiratory symptoms, cardiovascular conditions, and even childhood cancers. However, most of these studies focused on children or highly rural settings, and few examined adult populations in urban areas, making comparisons to our study somewhat limited.

Research on cancer risks related to oil and gas exposure remains to be examined further. While there are reports of increased risks of specific cancers, like leukemia, among those living near oil fields in other states, these studies are often in regions with higher levels of drilling activity than our study area. In contrast, our findings showed no significant association between proximity or wind direction and cancer in multivariate models controlling for potential covariates; however, our use of self-reported data and a cross-sectional design limited our ability to detect potential long-term health effects, including cancer, which may require decades to develop and thus long term follow-up. Furthermore, we have not verified or confirmed reported cancer through medical record review. No prior studies in California have specifically addressed these health outcomes in relation to urban oil fields like the IOF.

(3) Strengths and limitations

This study has several strengths. Firstly, we used carefully designed address-based sampling with multi-factor stratification. Even though the sampling plan did not generate a sufficient response, the widespread convenience sampling resulted in a well-distributed study sample across radius distance from IOF fence line, a detailed assessment of symptoms and conditions across a diverse urban population and consideration of both proximity and wind direction as potential exposure variables. Secondly, we were able to compare self-reported health conditions with Los Angeles County averages, adding context to our findings.

Some study limitations, however, must be acknowledged. Firstly, our reliance on self-reported health conditions introduces potential inaccuracies, as these reports were not verified through medical records. Cancer, in particular, has a long latency period, which complicates detecting associations in a study based solely on self-reported data. Moreover, our sample size, while sufficient for exploratory analyses, may not be large enough to capture small but meaningful health differences, especially for conditions like cancer. The need to collapse distance categories in our models further reflects concerns over sample stability, which may have limited our ability to detect nuanced trends.

Another limitation is the cross-sectional nature of our study, which limits causal interpretations. Health outcomes such as high cholesterol or cancer may be influenced by numerous confounding factors over time, including lifestyle, socioeconomic status, and other environmental exposures, which we could not fully control. Additionally, the urban setting and moderate drilling activity around the IOF differed from areas examined in prior studies, potentially influencing the generalizability of our results.

Comparison Among Different Race/Ethnicity and Socioeconomic Groups

We analyzed the distance effects on health outcomes by race/ethnicity and socioeconomic status summarized in supplemental table 4 and 5. Both race/ethnicity and socioeconomic status influenced how proximity to oil production affected health. White individuals and those with a college degree showed more significant negative effects on lung function, particularly FEV1 and FVC, when living closer to oil production sites. In contrast, Black/African Americans, individuals in the "Other" race category, and those without a college degree showed smaller or non-significant changes, suggesting that the distance effect might vary based on both race/ethnicity and social economic status.

Race/Ethnicity:

- Black/African American: The effects of living closer to oil production sites on lung function (FEV1, FVC) and blood pressure (SBP, DBP) were relatively small and not statistically significant. For example, FEV1 was 0.09 lower for those living within 0.5 miles compared to the reference group, with a confidence interval that included zero, suggesting no clear effect.
- White: White individuals showed more pronounced effects. For example, living within 0.5 miles was associated with significantly lower FEV1 (-0.56 [CI: -0.90, -0.23]) and FVC (-0.76 [CI: -1.17, -0.36]). Blood pressure (DBP) also showed decreases for closer proximity however not statistically significant.
- Other: Individuals in the "Other" category exhibited smaller differences in health outcomes, similar to Black/African Americans. For example, FEV1 were -0.19 lower within 0.5 miles, but the confidence interval included zero, indicating an unclear effect.

Socioeconomic Status (SES):

- College Degree: Individuals with a college degree experienced noticeable lower lung function when they lived closer to oil production sites. For example, FEV1 was -0.42 [CI: -0.65, -0.19] lower for those within 0.5 miles. However, effects on blood pressure are less clear, with both SBP and DBP showing non-significant changes.
- No College Degree: The effects on those without a college degree were generally smaller and less consistent. For example, FEV1 were -0.21 [CI: -0.74, 0.32] lower within 0.5 miles compared to those farther away, but this was not statistically significant. Similarly, changes in blood pressure were minor and also not statistically significant.

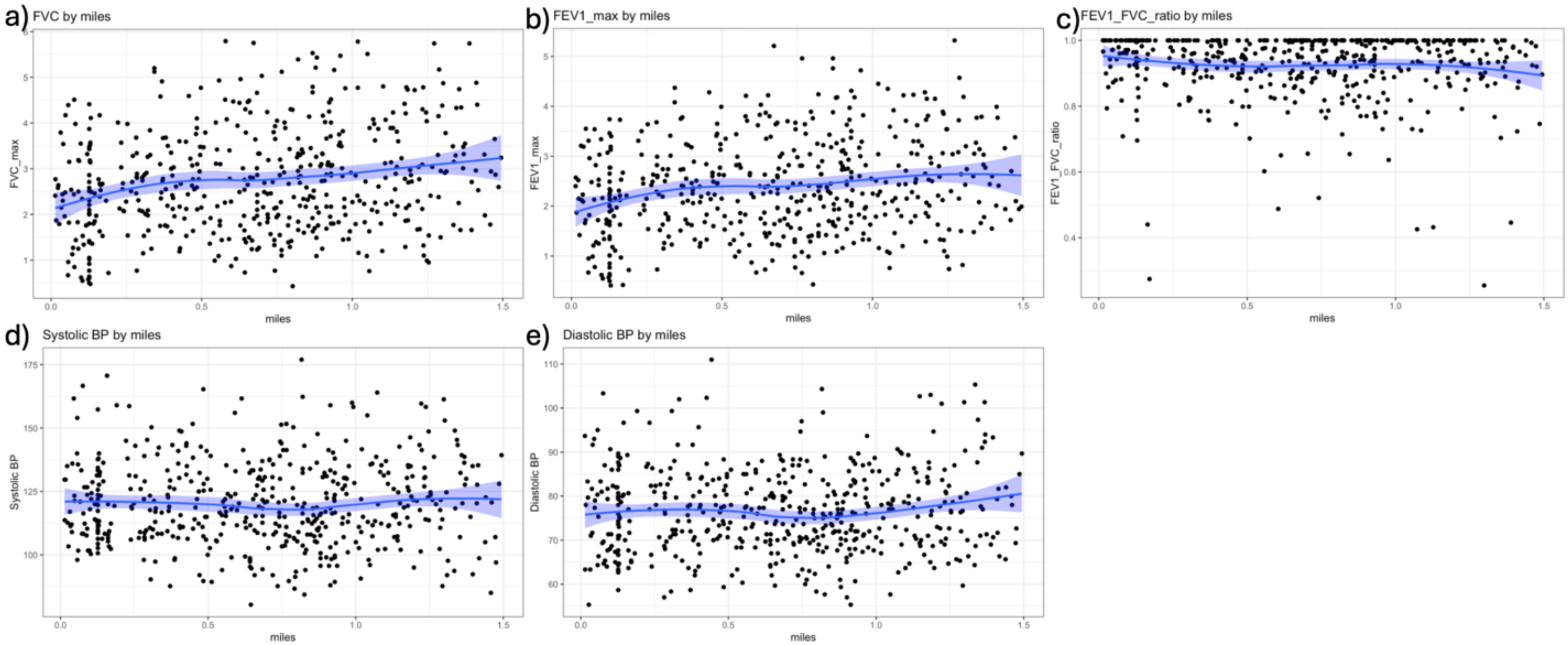
Supplemental Table 4: Association between Lung Function and Distance Stratified by Race/Ethnicity

Distance (Ref: 1-1.5 miles)	Race/Ethnicity	Lung Function: FEV1 (95% CI)	Lung Function: FVC (95% CI)	Blood Pressure: Systolic (95% CI)	Blood Pressure: Diastolic (95% CI)
0-0.5 miles	**Black / African American**	-0.09 [-0.45, 0.27]	0.03 [-0.39, 0.45]	-0.31 [-8.46, 7.83]	-0.20 [-5.18, 4.78]
	White	-0.56 [-0.90, -0.23]	-0.76 [-1.17, -0.36]	-2.50 [-8.35, 3.35]	-3.72 [-7.03, -0.42]
	Other	-0.19 [-0.53, 0.15]	-0.34 [-0.75, 0.07]	0.38 [-5.90, 6.66]	0.88 [-2.71, 4.47]
0.5-1 miles	**Black / African American**	-0.15 [-0.49, 0.20]	-0.01 [-0.41, 0.40]	-2.56 [-10.43, 5.30]	-2.92 [-7.73, 1.89]
	White	-0.16 [-0.50, 0.17]	-0.27 [-0.67, 0.13]	-4.98 [-10.77, 0.81]	-3.80 [-7.07, -0.53]
	Other	-0.17 [-0.50, 0.17]	-0.23 [-0.62, 0.17]	-3.93 [-10.04, 2.17]	-2.69 [-6.18, 0.80]

Supplemental Table 5: Association between Lung Function and Distance Stratified by Socioeconomic Status (Education)

Distance (Ref: 1-1.5 miles)	Education Level	Lung Function: FEV1 (95% CI)	Lung Function: FVC (95% CI)	Blood Pressure: Systolic (95% CI)	Blood Pressure: Diastolic (95% CI)
0-0.5 miles	**Completed college or higher**	-0.42 [-0.65, -0.19]	-0.53 [-0.81, -0.25]	0.36 [-3.89, 4.61]	-1.52 [-3.95, 0.91]
	No college degree	-0.21 [-0.74, 0.32]	-0.39 [-1.01, 0.23]	-3.61 [-12.59, 5.37]	-1.57 [-6.77, 3.63]
0.5-1 miles	**Completed college or higher**	-0.20 [-0.43, 0.03]	-0.24 [-0.51, 0.04]	-2.81 [-7.03, 1.41]	-3.22 [-5.62, -0.81]
	No college degree	-0.18 [-0.65, 0.29]	-0.23 [-0.78, 0.32]	-5.07 [-13.08, 2.94]	-2.33 [-6.97, 2.31]

Appendices



Supplemental Figure 1: Scatterplot of a) FVC b) FEV1 c) FEV1/FVC ratio d) Systolic BP e) Diastolic BP by miles from the IOF boundary.
Note: The blue band represents the 95% confidence interval (CI) from the loess regression

Attachment 1: Community Health Assessment Advisory Panel Feedback Table: 2021-2022

Community Health Assessment Advisory Panel Feedback

What Suggestions We Heard	***How We Responded***
Use Dropbox or another file sharing site so that CHAAP members can make comments on documents in progress.	Created shared Box folder for CHAAP members and UCLA research team to utilize for sharing/exchanging documents.
Suggested considering wind direction in the exposure metric.	Research team reached out to MRS who provided wind roses based on the Baldwin Hills meteorological station which could be used to define “upwind” and “downwind” populations.
Suggestion to include a cancer study.	Included questions on the household survey assessing cancer incidence and mortality.
Suggestion to add time at the end of the meeting to answer CHAAP members’ questions not related to discussion points	Allotted 10 minutes at the end of each CHAAP meeting for members to ask additional q’s and circle back to q’s asked earlier that were not relevant to the discussion
Suggestion to create a table with biometric measures illustrating requirements, pros and cons, alternate suggestions, rankings, and have opportunity to vote on them (e.g., lung function- are there any other measures, what will it accomplish, and explanation of why decision was made).	Research team created and presented a decision analysis table during a CHAAP meeting with potential biometric and biomarker measures, literature linking each biometric/biomarker measure to oil and gas and/or air pollution, and a ranking of cost and level of invasiveness. Presented questions for discussion about the table during the CHAAP meeting for members to provide their input on the options of biometric/biomarker measures.

Suggestion to include more than wells in production and to include abandoned and plugged wells in parcel map presented to the CHAAP	Updated and shared parcel maps at varying distances (0.5 mi., 1 mi., 1.5 mi, etc) with plugged and abandoned wells
Member asked if research team can discuss how the participants will be randomly assigned	Presented information about sampling methods to the CHAAP during a monthly meeting
Member suggested doing a comparison study between residents living at 1 mi. away from oil field vs 2 mi	Research team included this suggestion in the analysis plan
Member suggested making a connection between air pollutants identified in studies performed on Inglewood Oil Field (IOF) and those measured in the study.	Research team included a control site (unexposed population) into the analysis plan to identify and separate what pollutants derive from IOF and traffic related sources
Members expressed support for incorporating a urine analysis, such as S-PMA and 2-PHECA biomarkers, into the study	Research team is exploring options for incorporating a urine analysis into the study (NOTE: capability to include a urine analysis is limited by budget of the study)
Members expressed support for boundary of primary data collection to be anywhere between a few thousand ft. of the IOF up to 2 mi. of the IOF	With consideration of the CHAAP's feedback, the research team decided to set the boundary to 1.5 mi.
Member recommended capturing environmental justice aspect of study by including a self-report question in the survey about whether residents feel heard and acknowledged, or if they feel underserved	Research team included questions about residents' perceptions of living near the IOF
Members expressed support for including reproductive health as a domain in the household survey	A section on reproductive health was added to the survey
Member expressed support for inclusion of environmental nuisances	A section on environmental nuisances was added to the survey

Member suggested including a question about how old residents' homes are	Item added to the survey which asks how old residents' homes are
Member suggested including a question about whether residents are aware of IOF and how they feel about living near the oil field.	Questions added to the survey about residents' perceptions about living near the IOF
Member suggested including a question in the survey about whether another immediate member of the participant's family has ever been diagnosed with cancer or has passed away from cancer	Questions added to the survey asking whether another household member had been diagnosed with cancer, what year they received this diagnosis, and whether they passed away from cancer
Member suggested incorporating questions related to historical redlining in survey	Questions about impacts of redlining (e.g., "if you did not experience financial constraints, would you still choose to live in close proximity to the oil field?")
Member suggested including a question about length of residency	Question added to the survey asking how long residents have lived in the neighborhood
Member suggested including a question about participant's access to health care as a way to assess for income	Questions about access to health care services included in the survey
Member suggested approaching questions in a way that assumes the participant has not visited a doctor	Questions included in the survey about frequency accessing health care services
Member suggested asking a combination about both physical health symptoms and preexisting health conditions	Questions about physical health symptoms and preexisting health conditions added to the survey
MRS representative suggested using CalEnviroScreen or SB 535 Disadvantaged Communities to draw information	Questions on demographics placed at the end of the survey. Included question on household income level and excluded some questions assessing for income

about SES to maintain succinct, brief survey. Recommended focusing more on questions about health impacts rather than collecting additional information about SES that can be collected from these tools.	
Members expressed support for having multiple survey modes in order to be accommodating	The survey will be disseminated via multiple modes
Members expressed support for using a computer-assisted web interview (CAWI) as the foundation for the household survey	Research team will be using CAWI as the main mode to disseminate the survey
Members expressed support for traditional paper and pencil survey mode	Research team will use paper and pencil survey mode as an option for participants
Members expressed support for computer-assisted telephone interview (CATI) for the survey	Research team will use CATI as a survey mode
Member suggested combining a cluster sampling method and stratified sampling method to identify potential participants for the household survey	Research team will combine the cluster sampling method with a stratified random sample

Attachment 2: Community Health Assessment Advisory Panel Feedback Table: 2022-2023

Community Health Assessment Advisory Panel Feedback

What Suggestions We Heard	***How We Responded***
Member suggested considering how exposure is also a phenomenon that occurs during the evening. When the air is cooler, and the wind goes down, methane (lighter gas) pulls up other toxic gases (e.g., BTEX) which are heavier gases. When there is little wind, they follow the elevation pathways (process called gravity drainage) and the toxins follow the terrain towards the residential areas near the IOF	
Members suggested holding biometric screening events at public locations such as farmer's markets, parks, HOA offices, and churches, for a total of 5-6 community centers local residents are already familiar with.	Research team will contact suggested public locations to hold biometric screening events
Member suggested having researchers assist participants with completing surveys at the biometric data collection events	Research team will have researchers and student interns at biometric data collection events to assist participants
Member suggested creating a website where participants can enroll in the study	Research team will look into creating a website for the study
Members suggested revisions to the recruitment flyer include a map of the communities near the IOF, include photos with more representation of the community members,	Research team will include photos with more representation of the community members

Member suggested reaching out to local organizations to bring awareness that this research study is being done. Suggested connecting with local radio stations, newspapers, and other organizations to bring more. Suggested having notices in local parks to inform potential participants that this study is coming and be on the lookout if they receive an invitation to participate. attention to this study	Research team will reach out to a few local organizations to bring awareness about the study
Member suggested doing a visual presentation in a local park or other local area to gain awareness for the study so potential participants don't throw away any notices about the study they receive in the mail	Research team will contact local park and discuss the matter
Member suggested highlighting Los Angeles County Public Health's name on the flyer and to include the same marketing on the envelope to ensure recognition between announcement flyers and recruitment letter	Los Angeles County Public Health's name has been highlighted on the flyer
Member suggested to underline the "may" receive a letter by mail to emphasize.	The word "may" has been emphasized on the letter
Member suggested changing wording in the flyer from "cooperation" to "participation"	Wording in the flyer has been changed to "participation"
RE: Birth outcomes analysis; Member suggested that it would be important to differentiate the different types of rigs, given that there haven't been new drilling rigs since 2014.	Research team will look into differentiate the different types of rigs
RE: Birth outcomes analysis; Member mentioned that it would be informative to look at inactive/ idle wells.	Research team will look into inactive wells

Member suggested that the team can leverage social media and outreach to district supervisor who has a large following, and it would reach a lot of people. However, the member does not have a specific contact yet, but can try to look for a close connection to reach supervisor Mitchell.	Los Angeles County Public Health shared flyer on their social media. Research team will discuss further about contacting district supervisor to share the study's flyer
A CHAAP member recommended reaching out to churches and local organizations for photos to use in the recruitment flyer and would also be a good way of establishing a connection.	Research team will contact churches around the area to help distribute flyers
A CHAAP member suggested to utilize radio station KBLA with Tavis Smiley, the major churches in the area, and the newspaper LA Sentinel	Research team will look into utilize the radio station

Attachment 3: Community Health Assessment Advisory Panel Feedback Table: 2023-2024

Community Health Assessment Advisory Panel Feedback

What Suggestions We Heard	***How We Responded***
Member recommended adding more biometric data collection locations in the South area of the Inglewood Oil Field (IOF)	Research team included two more locations in the South.
Member suggested modifying the letter of invitation to make it easier for participants to understand	Research team modified the letter together with the member during CHAAP meeting
Member suggested having more biometric data collection sessions during the weekend, especially Saturday	Research team ran two sessions on Saturday, on both the West and South area of IOF
Member recommended the team to use social media for outreach and recruitment to reach the younger population	Research team created social media account and advertised the study to recruit younger participants
Member suggested adding the study logo and Los Angeles County Public Health on the envelope, and adding the sentence “Invitation To Participate In Health Study”	Research team added the logos and the sentence to the envelope
Member suggested sharing the participant distribution map with community members to show that their area is underrepresented	Research team was unable to share the map with community members as it would reveal participants address
Member emphasized the importance of recruiting more participants on the East side and utilizing social media to spread information about the study	Research team added an additional location in the East side and agreed to reach out to different places and attend events to recruit more participants

Member asked if the team would be able to determine how many participants live directly within the 1000ft perimeter	Research team confirmed that the team can since they have the address list
Member suggested the team reach out to churches on the east side of the oil field to promote the study	Research team contacted the suggested churches on the east side but churches felt skeptical and hesitant to promote about the study
Member emphasized the importance of avoiding bias and not associating the study with politicians	Research team noted the member's concern and confirmed that they won't be working with politicians
Member suggested developing a document or summary explaining the research methodology and how it will lead to reliable conclusions about the health impacts	Research team confirmed that they will include a summary explaining the methodology in the final report
Member suggested sending out a press release to media outlets to generate awareness and potentially enroll more participants	Research team contacted different cities around the IOF and City of Culver City shared the study's flyer and contact information on the website and newsletter. Research team also worked with a local radio station to promote the study for 30 days.
Member emphasized the need for a separate meeting to review and discuss the study findings	Research team agreed and confirmed that they will create separate meeting when the time comes.
Member suggested using popular locations and community events in Culver City to recruit more participants	Research team reached out to different locations and got invited to table at the Stoneview Nature Center events
Member suggested reaching out to LAUSD and the Windsor Hills Magnet School for potential collaboration and recruitment opportunities	Research team contacted LAUSD schools around the area and dropped off flyers at schools that responded
Member suggested implementing color-coded visual display for improved clarity of data charts	Research team agreed to the suggestion and confirmed that they will change the color of data charts

Member discussed past and ongoing health impact studies in relation to the oil field, emphasizing the need to avoid premature conclusions until all data are analyzed	Research team agreed to the suggestion and confirmed that they will avoid making premature conclusions
Members suggested add blank space on the map to identify areas that are not occupied by houses. Member also proposed to create an overlay for clearer visualization of these areas.	Research team is currently looking into using a map that color codes tax parcels
Members suggested the UCLA team to conduct a sensitivity analysis for the two cluster areas to check for any perceived bias in the biometric data	Research team responded that they will look into this
Member suggested considering elevation and reviewing whether it is related to birth outcomes, in addition to proximity to the oil field	Research team responded that there haven't been any studies linking elevation to the study's birth outcomes but the team could look more into this
Member suggested to incorporating a health risk assessment report for the Inglewood Oil comprehensive data consideration	Research team is considering this suggestion
Member highlighted the necessity of considering findings from the Lost Hills snap study in the Inglewood Oil Field study, particularly chemicals listed in the Inglewood report.	Research team is currently reviewing the Lost Hills study and will consider the findings if they are related
Member asked for the SNAP data to be considered in the report; and wants to know the status on this	Research team is currently reviewing the SNAP data and will update members in future meeting whether it will be considered in the report.
Member suggested there needs to be a strategy to introduce the Hispanic/Latino community to the study, for example, reaching out to a Latino statistician and asked them what they would recommend	Research team responded that they will reach out to some colleagues at UCLA
Member suggested including the socio-economic and ethnicity from the report for the houses surrounding the oil field	Research team responded that they will include this in the report

Member asked how will the Lost Hills data be included in the study and asked for a follow-up on this	Research team responded that they will stay on top of this
Member suggested to reviewing dietary issues and exercise present in August	Research team responded that they will review dietary issues and exercise present in August
Member asked on how truthful self-reported information is. Requested taking lung function against the self-reported information, inclusion of disadvantaged communities and conducting a reversed analysis	Research team will include lung function against the self-reported information, include disadvantaged communities and conduct a reversed analysis as requested
Member requested to include the Lost Hills findings into the BHHA study	Research team will respond and include the Lost Hills findings into the BHHA study

Attachment 4: Community Health Assessment Advisory Panel Feedback Table: 2024-2025

Community Health Assessment Advisory Panel Feedback

What Suggestions We Heard	***How We Responded***
Member request to take into account the traffic pollution into the analysis (e.g. include La Cienega Blvd in the definition of main rounds in calculating if participants live within 200 meters from major roads).	Research team confirmed that this is included in the analysis.
Member request to include biometric data in informing local health policies and programs.	Research team confirmed that comprehensive report including biometric data will be shared with community health partners and policymakers.
Member suggested simplified consent forms and clearer communication around privacy protection in order to improve participation in biometric data collection.	Research team re-engaged participants who did not complete the biometric data collection to ensure the findings are as comprehensive as possible.
Member requests an explanation of the types of biases relevant to the study to be included in the final report.	Research team explained the types of biases relevant to the study and confirmed they will be explained in the final report.
Member requests that lifestyle habits be broken down by up vs. downwind and by ages.	Research team confirms these will be calculated and provided.
Member suggests that the unadjusted data from the analysis should not be shared with the public due to potential confusion.	Research team confirms that the unadjusted data won't be included in the public report.
Member suggests that when speaking with the public to speak generally, rather than just focusing on statistical language and results.	Research team confirms they will take this into account when speaking with the public.

Member advised breaking up presentation slides containing data and results of outcomes in regards to living close to the IOF compared to LA county.	Research team confirms they will split the slides for ease of understanding.
Member asks for red-green color scheme of tables to be updated, as red and green can imply negative and positive but as current was opposite of positive and negative outcomes.	Research team confirms the color scheme will be updated.
Member saw a high percentage of people having a history of a high blood pressure. Member asked if there is a way to eliminate those who are taking blood pressure medication as it might skew the result.	Research team responded that they have not done this yet but it's possible and will do so in the future
Member asks for acronyms such as ACS to be explained for those who may be unaware in the public.	Research team confirms that acronyms will be explained.
Member requested the research team to control for the traffic since some areas have heavy traffic, especially areas near the airports and highway	Research team responded that they will look into controlling for traffic around the IOF as they continue to write the report

Attachment 5: Baldwin Hills Health Assessment and Environmental Justice Study Household Survey

Baldwin Hills Health Assessment and Environmental Justice Study

The purpose of this survey is to help us gather information about the health of people living near the Inglewood Oil Field. This survey is confidential. Your participation in this study is completely voluntary. No individual answers will be identified with a name or household. Your answers will be combined with the answers we collect from all other participates in the study. We ask that you answer the questions as honestly as possible. We will be very careful to protect your confidentiality (https://ohrpp.research.ucla.edu/policies-and-guidance/).

The following questions ask about different areas of your life, including health conditions, lifestyle, and your current and past experiences. Please take as much time to think about your answers as you need. Altogether, this questionnaire should take about 25-30 minutes.

1. Please enter your subject ID* (SUB_ID)
2. Please enter your First and Last Name* (SUB_NAME)

Please provide one or more of your preferred forms of communication. This information will not be shared and will be used solely for the purpose of contacting you regarding the in-person collection of blood pressure and lung function measures.

1. Please enter your mailing address (optional) (MAILADD)
2. Please enter your email (optional) (EMAILADD)
3. Please enter your telephone number (optional) (SUB_TEL)

SECTION I – DEMOGRAPHICS

The following questions are to provide us with a better understanding of your background.

1. [DG_RACE] Which one of these groups would you say best represents your race or ethnicity? (Please select all that apply.)
   - o Black or African American
   - o Asian or Asian American
   - o Hispanic/ Latinx (Mexican, Mexican American, Chicano/a, Central American, South American, Puerto Rican, Cuban, Dominican, Haitian, Another Hispanic, Latinx, or Spanish origin, etc.)

- American Indian or Alaska Native
- Native Hawaiian or Pacific Islander
- Middle Eastern or North African
- White or Caucasian
- Other ____

2. [DG_INC] What is your annual household income level?
   - Less than $20,000
   - $20,000 – $50,000
   - $50,001 – $100,000
   - $100,001 – $150,000
   - More than $150,000
   - Prefer not to say

3. [DG_EDU] What is the highest degree you received?
   - No high school nor equivalent degree
   - Some high school
   - High school diploma or equivalent
   - Technical degree/Some college/Associates degree
   - College graduate
   - Post-graduate degree
   - Prefer not to say

4. [DG_SEX] What is your sex assigned at birth?
   - Male
   - Female
   - Prefer not to say

5. [DG_GEN] You currently describe yourself as:
   - Male
   - Female
   - Transgender

- o Non-binary
- o None of these
- o Prefer not to say

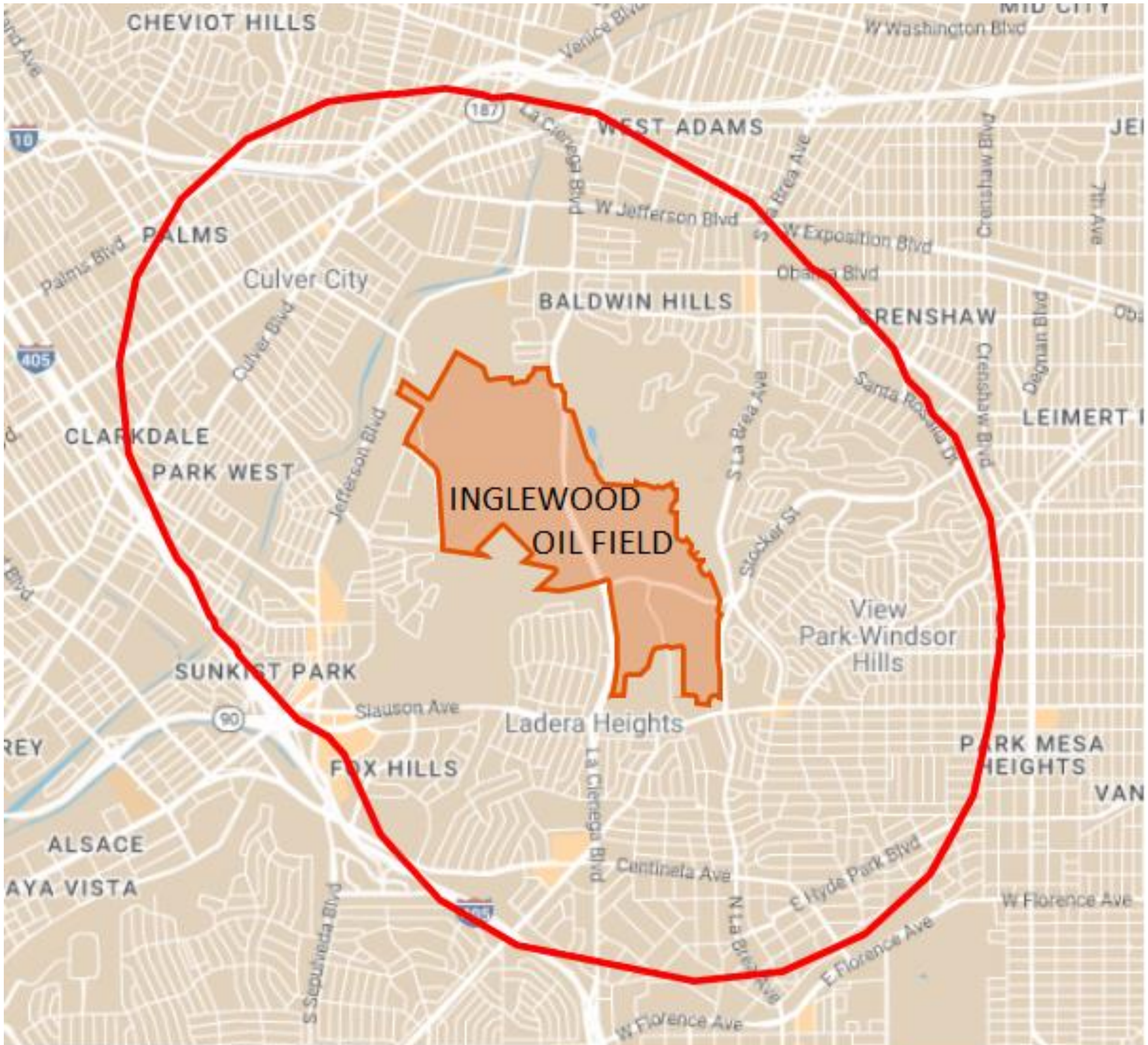
6. [DG_LANG] What language do you speak most at home?
    - o English
    - o Spanish
    - o Other, please specify: _____

7. [DG_BORN] In what country were you born in?
    - o United States
    - o Other, please specify: _____
    - o Prefer not to say

SECITON II - HOUSEHOLD CHARACTERISTICS

We will now ask you questions about your home.

8. [HH_YRADD] How many years have you been living at your current address? ______
    - o Don't know



9. [HH_NEI] The image above shows the neighborhood that is within 1.5 miles of the Inglewood Oil Field fence line. How many years have you been living in this neighborhood? Please see the circled image above for reference ______

- o Don't know

10. [HH_PPL] How many people live in your household? _________ # household residents

11. [HH_BUILT] In what year was your home built? Your best guess is acceptable:_______
    - o Don't know

12. [HH_WOS] Do you work outside your home?
    - o Yes
    - o No, skip to question 14
    - o Sometimes

13. [HH_TRAN] What form of transportation do you use to get to work?
    - o Car
    - o Bus
    - o Bicycle
    - o Walk
    - o Other, please specify; _______

14. [HH_OCC] What is your occupation? _____________________

15. [HH_WIOF] Do you work on/near the Inglewood Oil Field?
    - o Yes, please specify how close (in miles). Your best guess is fine: ________
    - o No

16. [INDAY&C] How many hours do you spend <u>indoors</u> at your home during a typical <u>weekday</u>? (Mon-Fri)

a. Number of hours in the morning (8AM-12PM) __________
- ○ Don't know

b. Number of hours in the afternoon (12 PM- 4 PM) __________
- ○ Don't know

c. Number of hours in the evening (4 PM-10PM) __________
- ○ Don't know

d. Number of hours at night (10 PM-8AM) ___________
- ○ Don't know

17. [INWKD&C] How many hours do you spend <u>indoors</u> at your home during a typical <u>weekend day</u>? (Sat -Sun)

a. Number of hours in the morning (8AM-12PM) ___________
- ○ Don't know

b. Number of hours in the afternoon (12 PM- 4 PM) ___________
- ○ Don't know

c. Number of hours in the evening (4 PM-10PM) ___________
- ○ Don't know

d. Number of hours at night (10 PM-8AM) ___________
- ○ Don't know

18. [OUTDAY&C] How many hours do you spend <u>outdoors</u> in your neighborhood during a typical <u>weekday</u>? (Mon-Fri)

a. Number of hours in the morning (8AM-12PM) ___________
- ○ Don't know

b. Number of hours in the afternoon (12 PM- 4 PM) ___________
- ○ Don't know

c. Number of hours in the evening (4 PM-10PM) ___________
- ○ Don't know

d. Number of hours at night (10 PM-8AM) ___________
- ○ Don't know

19. [OUTWKD&C] How many hours do you spend <u>outdoors</u> in your neighborhood during a typical <u>weekend day</u>? (Sat-Sun)

a. Number of hours in the morning (8AM-12PM) ___________
- ○ Don't know

b. Number of hours in the afternoon (12 PM- 4 PM) ___________
- ○ Don't know

c. Number of hours in the evening (4 PM-10PM) ___________
- ○ Don't know

d. Number of hours at night (10 PM-8AM) ___________
- ○ Don't know

20. [HH_TYPE] Which of the following best describes the house you currently live in?
    - Single-family detached home
    - Condominium or townhouse
    - Duplex or triplex
    - Apartment building with 14 units or less
    - Apartment building with 15 units or more
    - Mobile or manufactured home
    - Other ____

21. [HH_GAR] Does this home have a garage?
    - Yes
    - No
    - Not applicable

22. [HH_RENT] Do you currently rent or own your home?
    - Rent
    - Own
    - Other arrangement
    - Prefer not to say

23. [HH_AC] What type of air conditioning or cooling system, if any, do you have to cool or circulate the air in your home? Please select all that apply.
    - Central air conditioning
    - One air conditioning unit
    - More than one air conditioning unit
    - Swamp cooler (also called an evaporative cooler)
    - Fan
    - No air conditioning
    - Don't know

24. [HH_HEPA] Do you have a HEPA filter in your air-cooling system?
    - Yes

- No
- Don't know

25. [HH_USEAC] Do you use the air conditioning or cooling system in your home?
    - Yes
    - No
    - Don't know

26. [HH_HEAT] Do you use a heating system in your home?
    - Yes
    - No, skip to question 29
    - Don't know, skip to question 29

27. [HH_TYHT] What type of heating system do you use in your home? Select all that apply.
    - Gas
    - Electric
    - Space heater (portable unit)
    - Wood- or pellet-burning stove
    - Gas fireplace
    - Wood-burning fireplace
    - Other, please specify: _______
    - Don't know

28. [HH_FRQHT] How often do you use the heating system during cold/winter months?
    - Every day or almost every day
    - Several times a week
    - Several times a month
    - Less than several times a month

- Never

29. [HH_OPWD] How often do you open the windows to ventilate your home in the summer?
    - Every day or almost every day
    - Several times a week
    - Several times a month
    - Less than several times a month
    - Never

30. [HH_OPWD] How often do you open the windows to ventilate your home in the winter?
    - Every day or almost every day
    - Several times a week
    - Several times a month
    - Less than several times a month
    - Never

31. [HH_PURE] Do you have a portable air cleanser/air purifier?
    - Yes
    - No, skip to question 33
    - Don’t know, skip to question 33

32. [HH_FRQP] How often do you use your air cleanser/purifier?
    - Every day
    - A few days per week
    - A few days per month
    - Rarely
    - Never
    - Other, specify: __________
    - Don’t know

33. [HH_HUMI] Do you have a humidifier?
    - Yes
    - No, skip to question 35

- Don’t know, skip to question 35

34. [HH_FRQU] How often do you use a humidifier?
    - Every day
    - A few days per week
    - A few days per month
    - Rarely
    - Never
    - Other, specify: __________
    - Don’t know

35. [GH_STV] What type of stove do you use for cooking?
    - Gas stove
    - Electric stove
    - Other, _________

36. [GH_FAN] Do you have a working exhaust hood or vent fan above your stove? (*An exhaust hood/vent fan pulls air, vapors, and odors out of the cooking area.)*
    - Yes
    - No, skip to question 38
    - Don’t know

37. [GH_FANF] How often do you use your stove exhaust hood or vent fan when you prepare food?
    - Every time I cook
    - Sometimes when I cook
    - Never
    - Don’t know

38. [HH_12IO] Things like smog, automobile exhaust, and chemicals can cause outdoor air pollution. In the past 12 months, have you had an illness or symptom that you think was caused by pollution in the air outdoors?

- o Yes, please specify the symptom(s) or illness: _______
- o No
- o Don't know

39. [HH_12II] Things like dust, mold, smoke, and chemicals inside a home can cause poor indoor air quality. In the past 12 months, have you had an illness or symptom that you think was caused by something in the air inside your home?
    - o Yes, please specify the symptom(s) or illness: _______
    - o No
    - o Don't know

Section III – HEALTH CARE

The following questions are about health care services.

40. [HC_PL4H] What kind of place do you go to most when you are sick or need advice about your health– an urgent care clinic, doctor's office, emergency room, or some other place?
    - o Urgent care clinic
    - o Doctor's office
    - o Emergency room
    - o Other, please specify: _______

41. [HC_TM4H] About how long has it been since you last saw or talked to a doctor or other health care professional about your own health?
    - o One year ago, or less
    - o More than 1 up to 2 years ago
    - o More than 2 up to 5 years ago
    - o More than 5 years ago
    - o Never
    - o Don't know

42. [HC_AP4H] How often did you get an appointment for a check-up at a doctor's office or clinic as soon as you needed?
    - o Very often

- o Somewhat often
- o Not often
- o Not very often
- o Never

Section IV - GENERAL HEALTH

The following questions are about general health conditions and lifestyle. All responses are confidential. We ask you to answer the questions as honestly as possible.

43. [GH_GH] Would you say that in general your health is excellent, very good, good, fair, poor, or very poor?
    - o Excellent
    - o Very Good
    - o Good
    - o Fair
    - o Poor
    - o Very poor
    - o Prefer not to say

44. [GH_T2B] Has a doctor or health professional ever told you that you had type II diabetes?
    - ○ Yes, please specify the year you were diagnosed: ______
    - ○ No
    - ○ Don't know
    - ○ Prefer not to say

45. [GH_HBP] Has a doctor or health professional ever told you that you had high blood pressure?
    - ○ Yes, please specify the year you were diagnosed: ______
    - ○ No
    - ○ Don't know
    - ○ Prefer not to say

46. [GH_ARTH] Are you now limited in any way from undertaking your usual activities because of arthritis or joint symptoms?
   - Yes
   - No
   - Don’t know
   - Prefer not to say

47. [GH_PAINA] Over the past 7 days, how many days have you had pain or aching from arthritis or joint symptoms?
   - Didn’t have any pain
   - Fewer than 1 day
   - 1-2 days
   - 3-4 days
   - 5-6 days
   - 7 days
   - Prefer not to say

48. [GH_CIGLF] Have you smoked at least 100 cigarettes in your entire life?
   - Yes
   - No
   - Don’t know
   - Prefer not to say

49. [GH_FRQC] How often do you smoke cigarettes now?
   - Every day
   - Some days
   - Not at all
   - Prefer not to say

50. [GH_CIGX] Do you currently smoke cigars, a pipe, a hookah or water pipe, e-cigarette/vaping devices, or chew smokeless tobacco? Select all that apply
   - Cigars
   - Pipe
   - Hookah/ Water Pipe

- E-cigarette or other vaping devices
- Smokeless tobacco
- No/ None of the above
- Other:___
- Prefer not to say

51. [GH_CIGRS] Does anyone who live in your home, including yourself, smoke in the house?
   - Yes
   - No, skip to question 53
   - Don’t know, skip to question 53

52. [GH_RESC] How many people smoke inside this residence?
Number of people smoking inside the residence _______________
   - Don’t know

53. [GH_VISC] Do your home visitors ever smoke in your home?
   - Yes
   - No, skip to question 55
   - Don’t know, skip to question 55

If resident(s) AND/OR visitors smoke in residence…

54. [GH_NUMC] What is the approximate total number of cigarettes smoked in your residence on a typical day?
   ______ number of cigarettes smoked in residence (1 pack = 20 cigarettes)
   - Don’t know

Think about the foods you ate or drank during the past month, including meals and snacks.

55. [GH_FRT] On an average week, how often do you eat fruit? Do not count juices. Your best guess is accepted.

   __________times

56. [GH_FF] How often do you eat from a fast-food restaurant, including meals and snacks, like McDonalds, Taco Bell or another similar type of place?
   - 4 or more times per week
   - 1-3 times per week
   - 1-2 times a month
   - Fewer than once a month
   - Never

57. [GH_BAL] On an average week, often do you eat a well-balanced, healthy and nutritious meal?
   - 4 or more times per week
   - 1-3 times per week
   - 1-2 times a month
   - Fewer than once a month
   - Don't know

Section V. ACUTE/SHORT-TERM SYMPTOMS

The following questions are about acute, or short-term, health symptoms or illness you may have experienced in the past 2 weeks.

58. [AS_SY] Thinking about your health in the past 2 weeks, have you experienced any of the following symptoms?

	Not at all	Once or twice	A few times per week	Daily
○ Frequent or chronic cough	0 ☐	1 ☐	2 ☐	3 ☐
○ Sore throat	0 ☐	1 ☐	2 ☐	3 ☐
○ Hay fever	0 ☐	1 ☐	2 ☐	3 ☐
○ Nausea	0 ☐	1 ☐	2 ☐	3 ☐
○ Vomiting	0 ☐	1 ☐	2 ☐	3 ☐
○ Rashes	0 ☐	1 ☐	2 ☐	3 ☐
○ Headache	0 ☐	1 ☐	2 ☐	3 ☐
○ Nose bleeds	0 ☐	1 ☐	2 ☐	3 ☐
○ Wheezing/whistling in the chest	0 ☐	1 ☐	2 ☐	3 ☐

○ Sleep disturbance by wheeze	0 ☐	1 ☐	2 ☐	3 ☐
○ Morning cough every day	0 ☐	1 ☐	2 ☐	3 ☐
○ Sneezing or runny nose	0 ☐	1 ☐	2 ☐	3 ☐
○ Tightness in the chest	0 ☐	1 ☐	2 ☐	3 ☐
○ Irritation of the eyes/watery eyes	0 ☐	1 ☐	2 ☐	3 ☐
○ Irritation of the nose	0 ☐	1 ☐	2 ☐	3 ☐
○ Dizziness	0 ☐	1 ☐	2 ☐	3 ☐
○ Fatigue	0 ☐	1 ☐	2 ☐	3 ☐
○ Diarrhea	0 ☐	1 ☐	2 ☐	3 ☐
○ Ringing of the ears	0 ☐	1 ☐	2 ☐	3 ☐
○ Backache	0 ☐	1 ☐	2 ☐	3 ☐
○ Ringing of the ears	0 ☐	1 ☐	2 ☐	3 ☐
○ Seizure	0 ☐	1 ☐	2 ☐	3 ☐
○ Trouble hearing	0 ☐	1 ☐	2 ☐	3 ☐
○ Chest tightness	0 ☐	1 ☐	2 ☐	3 ☐
○ Runny nose	0 ☐	1 ☐	2 ☐	3 ☐
○ Shortness of breath that becomes worse with physical activity	0 ☐	1 ☐	2 ☐	3 ☐

- o Other, please specify: __________
- o None of the above

Section VI. MENTAL HEALTH & LIFE EVENTS
The following questions are about mental health challenges you may have experienced in the last 2 weeks.

Please read each statement and check the box based on how much the statement applied to you over the past two weeks.

59. Below is a list of the ways you might have felt or behaved. Please tell me how often you have felt this way during the past week:

		Never	Almost never	Sometimes	Fairly often	Very often
a	felt that you were unable to control the important things in your life?	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐
b	felt confident about your ability to handle your personal problems?	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐
c	felt that things were going your way?	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐
d	felt difficulties were piling up so high that you could not overcome them?	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐

60. What do you think is the primary cause of your stress in the past weeks? Select all that apply
    - Parental stress (Children not respecting, feeling children are not safe, etc.)
    - Familial stress (Living with relatives, conflicts, etc.)
    - Employment stress (Dealing with tough employment conditions, etc.)
    - Socioeconomic stress (Feeling lonely-isolated, indebt, single parent, not having enough money, etc.)
    - Health stress (Dealing with own health issues or someone else in the family)
    - Racism-related stress (Being treated differently, being paid less due to your race, etc.)
    - Immigration stress (Concerned about immigration status, threats, loosing independence you had in country of birth, etc.)
    - Other:______

Section VII. PHYSICAL HEALTH AND ACTIVITY

The following questions are about levels of physical activity you engage in and frequency.

61. [PH_ETYP] In a typical week, how frequently do you engage in the following forms of physical activity:
    - At least one vigorous intensity sporting event, such as a running or biking event, which caused a large increase in your breathing or heart rate
    - At least 150 minutes of moderate-intensity sports, fitness, or recreational activities that cause a small increase in breathing or heart rate such as brisk walking
    - At least 75 minutes of vigorous-intensity sports, fitness, or recreational activities that cause large increases in breathing or heart rate like running

- Some exercise, specify how many minutes each week: ___________ minutes
- Other, please specify: ____________
- None of the above

62. [PH_EXTM] On an average week, how much time (in minutes) do you spend exercising outdoors in your neighborhood? ___________ minutes
    - I don't exercise outdoor

Section VIII. CARDIOVASCULAR HEALTH

The following questions are about cardiovascular health conditions you may be experiencing.

63. [CV_CVP] Has a doctor or other health professional ever told you that you have a heart problem, such as coronary heart disease, angina, or had a heart attack?
    - Yes, please specify the condition: _________
    - No, skip to question 65
    - Don't know, skip to question 65
    - Prefer not to say

64. [CV_CVY] What year were you diagnosed with this heart condition? _________

65. [CV_HCL] Has a doctor or health professional ever told you that you had high cholesterol?
    - Yes, please specify year of diagnosis: _______
    - No
    - Don't know
    - Prefer not to say

Section IX. RESPIRATORY HEALTH

The following questions are about respiratory health conditions you may be experiencing.

66. [EVER&C] Do you have any of the following respiratory conditions? Select all that apply.

RESPIRATORY CONDITION	YEAR OF DIAGNOSIS
○ Allergies	

○ Chronic bronchitis	
○ Chronic Obstructive Pulmonary Disease (COPD)	
○ Cystic fibrosis	
○ Emphysema	
○ Pneumonia	
○ Pulmonary fibrosis	
○ Tuberculosis	
○ None of the above	

67. Do you have any of the following allergies?

ALLERGIES	YES	NO	
○ Hay fever, grass or pollen			
○ Food allergies			If yes, what?
○ Drug allergies			If yes, what?
○ Dog or cat allergies			
○ Dust allergies			
○ Other allergies			If yes, what?

68. [RH_ASM] Has a doctor or other health professional <u>ever</u> told you that you have asthma?

- ○ Yes
- ○ No, skip to question 71
- ○ Don't know, skip to question 71

[RH_ASLY] In the past 12 months, have you had an asthma attack or any asthma symptoms, like difficulty breathing, wheezing, whistling, or tightness in the chest?

Yes
No
Don't know
Prefer not to answer

[RH_AST] In the past two days, have you taken any medicine to treat an asthma attack or asthma symptoms such as difficulty breathing, wheezing, whistling, or tightness in the chest? Include any medicine taken by nebulizer, inhaler, puffer, pill, or liquid.
Yes, please describe: ____
No
Don't know
Prefer not to answer

(Is there a child) (Are there children) in your household who (is) (are) under age 18 and (has) (have) ever been told by a doctor or other health professional that they (has) (have) asthma?
Yes
No
Don't know
Prefer not to answer

2. [RH_PLT] Have you ever lived or worked in a place with dirty or polluted air, smoke, second-hand smoke, or dust?
    - Yes
    - No, skip to question 75
    - Don't know, skip to question 75
    - Prefer not to say, skip to question 75

69. [RH_PLOC] Where did you live or work that exposed you to dirty or polluted air, smoke, second-hand smoke, or dust (can provide geographic area/ business location)? __________

70. [RH_PYR] What year(s) did you live or work in a place with dirty or polluted air, smoke, second-hand smoke, or dust (can provide geographic area/ business location)? __________

71. [RH_BRC] Does your breathing change with seasons, weather, or air quality?
    - Yes
    - No
    - Don't know

72. [RH_BRD] Does your breathing make it difficult to do things such as carry heavy loads, shovel dirt, jog, play tennis, or swim?
   - Yes
   - No
   - Don't know

73. [RH_PC19] Have you ever received a positive test result for COVID-19?
   - Yes, once
   - Yes, more than once
   - No, skip to question 79
   - Don't know, skip to question 79
   - Prefer not to say

74. [RH_C19S] Long-lasting COVID-19 symptoms could include tiredness, shortness of breath, changes to taste or smell, finding it hard to concentrate, or any other symptoms that impact on everyday functioning. Did you experience any of these symptoms for 2 months or longer after receiving a positive COVID-19 test result?
   - Yes
   - No
   - Don't know

Section X. REPRODUCTIVE HEALTH/PREGNANCYe

Pregnancy can be a difficult time. The following questions are about things that may have happened <u>before</u> and <u>during</u> pregnancy or while trying to conceive since living near the Inglewood Oil Field. If the following questions do not apply to you, please move forward to the next section of this survey (beginning with question 87).

75. [RP_PREG] Are you currently, or have you ever been, pregnant?
   - Yes
   - No
   - Don't know
   - Prefer not to say

76. [BIRYR&C] In what year was your child/children born?

# Children	Birth year

○ Child #1	
○ Child #2	
○ Child #3	
○ Child #4	
○ Child #5	

77. [RP_CHOS] Did any of your children need to stay in the hospital for longer than 24 hours after delivery?
    - ○ Yes, how many:___
    - ○ No
    - ○ My child was not born in a hospital
    - ○ My child is still in the hospital

78. [RP_CHRS] If your child/children stayed in the hospital for longer than 24 hours, what was/were the reason(s) for their extended stay? ______________________

79. [RP_CHYR] For each child that stayed in the hospital for longer than 24 hours, please list the year(s) they were born: ______________________

80. [RP_PCOM] Have you <u>ever</u> experienced any of the following complications during pregnancy while living near the Inglewood Oil Field? Select all that apply.
    - o Gestational diabetes
    - o Gestational hypertension
    - o Infection, including sexually transmitted infections (STIs)
    - o Preeclampsia
    - o Eclampsia
    - o Preterm labor or premature rupture of membranes
    - o Depression and/or anxiety
    - o Severe, persistent nausea and vomiting
    - o Pregnancy loss/ Miscarriage
    - o Ectopic pregnancy
    - o Other, please specify: _______________

81. Were any of your children born before completing 37 weeks of gestation (gestation is the time period between conception and birth)?
    - Yes. List the year(s) they were born:
    - No
    - Don't know

82. Did any of your children weigh 5.5 pounds (2500 grams) or less when they were born?
    - Yes. List the year(s) they were born:
    - No
    - Don't know

Section XI. NUISANCES AND ENVIRONMENTAL CONCERNS
The following questions are about disturbances you may be experiencing from sources outside of your home and how they affect your day-to-day life.

83. [NE_AWARE] Do you feel that the people living in communities around the Inglewood Oil Field are aware of the possible health impacts of living near the oil field?
    - Yes
    - No
    - Don't know

84. Are you concerned that living near the oil field might impact your health?
    - Yes
    - No
    - Don't know

85. [NE_NS] Below are different kinds of noises people sometimes hear in their neighborhoods. How much have these types of noise bothered you in the <u>past 6 months</u> – a great deal, somewhat, only a little or not at all?

    - Noise from cars and trucks

- A great deal
- Somewhat
- Only a little
- Not at all

- Noise from airplanes
  - A great deal
  - Somewhat
  - Only a little
  - Not at all

- Noise from oil field operations near your home
  - A great deal
  - Somewhat
  - Only a little
  - Not at all

- Noise from construction work
  - A great deal
  - Somewhat
  - Only a little
  - Not at all

- Noise from other sources
  - A great deal
  - Somewhat
  - Only a little
  - Not at all
  - Specify source(s): __________

86. [NE_NIN] Does the noise in your neighborhood prevent you from…?

- Keep windows open in your home
- Yes
- No
- Don't know

- Sleep
- Yes
- No
- Don't know

- Listen to the radio or television
- Yes
- No
- Don't know

- Talk on the phone
- Yes
- No
- Don't know

- Talk with others in your home
- Yes
- No
- Don't know

- Work from home
- Yes
- No
- Don’t know

- Study at home
- Yes
- No
- Don’t know

87. [NE_LP] Does light pollution- or excessive, misdirected, or intrusive artificial light from outdoors- cause disturbances in your household?
    - Yes, please specify the source of this light: __________
    - No
    - Don’t know

88. [NE_ODO] In the past 6 months, have you noticed any offensive odors in your neighborhood or while outdoors at your home?
    - Yes, please state the time of day that you notice the odor, and specify the source if known: __________
    - No
    - Don’t know

89. [NE_ODI] In the past 6 months, have you noticed any offensive odors in your home?
    - Yes, please state the time of day that you notice the odor, and specify the source if known: __________
    - No
    - Don’t know

90. [NE_VIB] In the past 6 months, have you felt ground vibrations in your home that you believe were coming from oil field operations?

- Yes
- No
- Don’t know

91. [NE_CAP] How much concern, if any, do you have about air pollution in your community?
    - Very concerned
    - Somewhat concerned
    - Not too concerned
    - Not concerned at all

92. [NE_CW] How much concern, if any, do you have about the safety of drinking water in your community?
    - Very concerned
    - Somewhat concerned
    - No too concerned
    - Not concerned at all

93. [NE_CHM] How much concern, if any, do you have about exposure to heavy metals (like lead, chromium, or arsenic) in your community?
    - Very concerned
    - Somewhat concerned
    - Not too concerned
    - Not concerned at all

94. [NE_CP] How much concern, if any, do you have about exposure to pesticides in your community?
    - Very concerned
    - Somewhat concerned
    - Not too concerned
    - Not concerned at all

95. [NE_CIOF] How much concern, if any, do you have that living near the Inglewood Oil Field could negatively affect your health?
    - Very concerned
    - Somewhat concerned

- Not too concerned
- Not concerned at all

96. [NE_COZ] Are there any other conditions impacting your community that you believe make it difficult to have healthy and safe living conditions? (Select all that apply)
    - Dumping trash and other items in creeks, storm drainage areas, and/or other sources of water
    - Access to food or nutrition assistance
    - Affordability of housing
    - Access to parks and recreation centers
    - Affordability of basic needs
    - Access to air filtration in the home
    - Ability to obtain a loan to move in/out of the community
    - Availability of affordable health care services (doctors, mental health professionals, dentists, hospitals, health insurance)
    - Lead-based paint in homes
    - Dust containing lead in homes or yards
    - Unsafe or unhealthy conditions in homes (such as mold, poor ventilation, needed repairs to ceiling or other parts of structure, or kitchen or bathroom that doesn't meet my needs or needs repair)
    - Strong odors inside the home
    - Strong odors in the neighborhood
    - Affordability of or access to air conditioning
    - Availability of health care services that are open at times that work for people who work during the day
    - Other, please specify: ____________

97. [NE_WEB] Are you familiar with the Inglewood Oil Field website and/or the Los Angeles County Department of Regional Planning website?
    - I am familiar with the Baldwin Hills Oil Field website
    - I am familiar with the LA County Department of Regional Planning website
    - I am familiar with both
    - I am not familiar with either

Section XII. CANCER

The following questions are about current or prior cancer diagnoses among yourself and other household members.

98. [CC_CC] Have you ever been told by a doctor or health professional that you had cancer?

- Yes, please specify the type of cancer: ___________
- No, skip to question 105
- Prefer not to say

99. [CC_CDG] What year were you diagnosed with this type of cancer? ______

100. [CC_COTH] Have you ever had any other kinds of cancer?

- Yes, please specify: _______
- No, skip to question 106
- Don't know, skip to question 106
- Prefer not to say

101. [CC_COY] What year were you diagnosed with this type of cancer? _______

102. [CC_COPL] Have you ever been told by a doctor or health professional that you had precancerous lesions?

- Yes, please specify the type of lesion: ___________
- No, skip to question 108
- Don't know, skip to question 108
- Prefer not to say

103. [CC_PLY] What year were you diagnosed with this type of precancerous lesion? _______

104. [CC_HHC] Has a member of your household, other than you, ever been diagnosed with cancer?

- Yes, please specify the type of cancer: ________
- No, skip to question 110
- Don't know, skip to question 110
- Prefer not to say

105. [CC_HHCY] What year were they diagnosed with this cancer? ______

Section XIII. ENVIRONMENTAL EXPOSURES (for in person data biometric collection)

This is the final section of the survey. The following questions are intended to assess other environmental sources that you may have been exposed to.

106. [EE_GF] Did you encounter any exposure to gasoline fumes (such as pumping gas) in the last 7 days?
   - o Yes
   - o No
   - o Don’t know

107. [EE_PCF] Were you exposed to any chemical fumes in the last 7 days, such as from cleaning product or home improvement (for example, paint)?
   - o Yes, please describe: _________
   - o No
   - o Don’t know

108. [EE_SITE] Were you on the site of an oil or gas well or other oil and gas facility (places other than where gasoline is sold) in the last 7 days?
   - o Yes
   - o No
   - o Don’t know

109. [EE_FIRE] Were you around a fire (including a stove or grill) or a burning fireplace at any point in the last 7 days?
   - o Yes
   - o No
   - o Don’t know

110. [EE_CIG] On how many of the past 7 days were you around someone else’s cigarette, cigar, e-cigarette, or pipe smoke in your home?
   - o None
   - o 1-2 days
   - o 3-4 days
   - o 5-6 days
   - o 7 days

- Don't know
- Prefer not to say

111. [EE_MAR] Did anyone smoke marijuana around you in the last 7 days?
    - Yes
    - No
    - Don't know
    - Prefer not to say

Thank you for taking the time to complete this survey. We appreciate you contributing your valuable time and honest information. The overall findings from this research study will be posted when available on the Los Angeles County Department of Regional Planning website (https://planning.lacounty.gov/ baldwinhills/study_2020). If you have any questions, please contact:

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[DATA COLLECTION LINK]

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