Project ENRRICH

A Public Health Assessment of Residential Proximity to a Goods Movement Railyard

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Project Funding

- **The BP/South Coast Air Quality Management District (AQMD) Public Benefits Oversight Committee**
  - Community Benefit Programs Addressing Conditions Caused or Exacerbated by Air Pollution

Principal Investigators

- Samuel Soret, PhD, MPH
- *Associate Dean for Public Health Practice, Office of Public Health Practice; and Executive Director, Center for Community Resilience*
- *Loma Linda University School of Public Health*
- Susanne Montgomery, PhD, MPH
- *Professor of Social Work and Social Policy, and Director of Research*
- *Behavioral Health Institute, Loma Linda University School of Behavioral Health*
- Rhonda Spencer-Hwang, DrPH, MPH
- *Assistant Professor, Center for Community Resilience*
- *Co-Investigator and Report Co-Author*

BACKGROUND

Goods Movement System

- Crucial component of modern society
- Potential community and health impacts
- Lack of societal concern about potential community impacts

Goods Movement

- Emerging concerns:
  - Residential proximity to high-traffic corridors
  - Disproportionate impacts
- Emission reduction strategies in response to concerns
  - Higher percentage of minority & low-income households residing near transportation corridors & hubs
  - Greater exposures, higher levels of ambient air pollutants, & enhanced vulnerabilities and psychosocial stressors

Goods Movement

- Increasing emissions: ships, trucks, and locomotives
  - Significant & growing
  - Adding to the entire region's air quality challenges
- Local community impacts
  - Railyards, rail lines, freeway corridors, and logistics/distribution centers
  - Local air pollution sources
  - Noise
  - Loss of sense of community-loss of property values
  - Adverse health effects at specific communities

Health Issues of Concern: Current Evidence

- Strong link between elevated particulate matter levels
  - Premature deaths
  - Worsen cardiovascular problems
  - Aggravated asthma
  - Other lower respiratory conditions
  - Miners Study[2]—NIH, National Cancer Institute
    - Evidence that diesel exhaust exposure may cause lung cancer in humans and may represent a potential public health burden

[1]Health Risk Assessment for the BNSF Railway San Bernardino Railyard, CARB 2008.

[2]Silverman et al., J Natl Cancer Inst 2012;104:1 8 –5 154– 868.

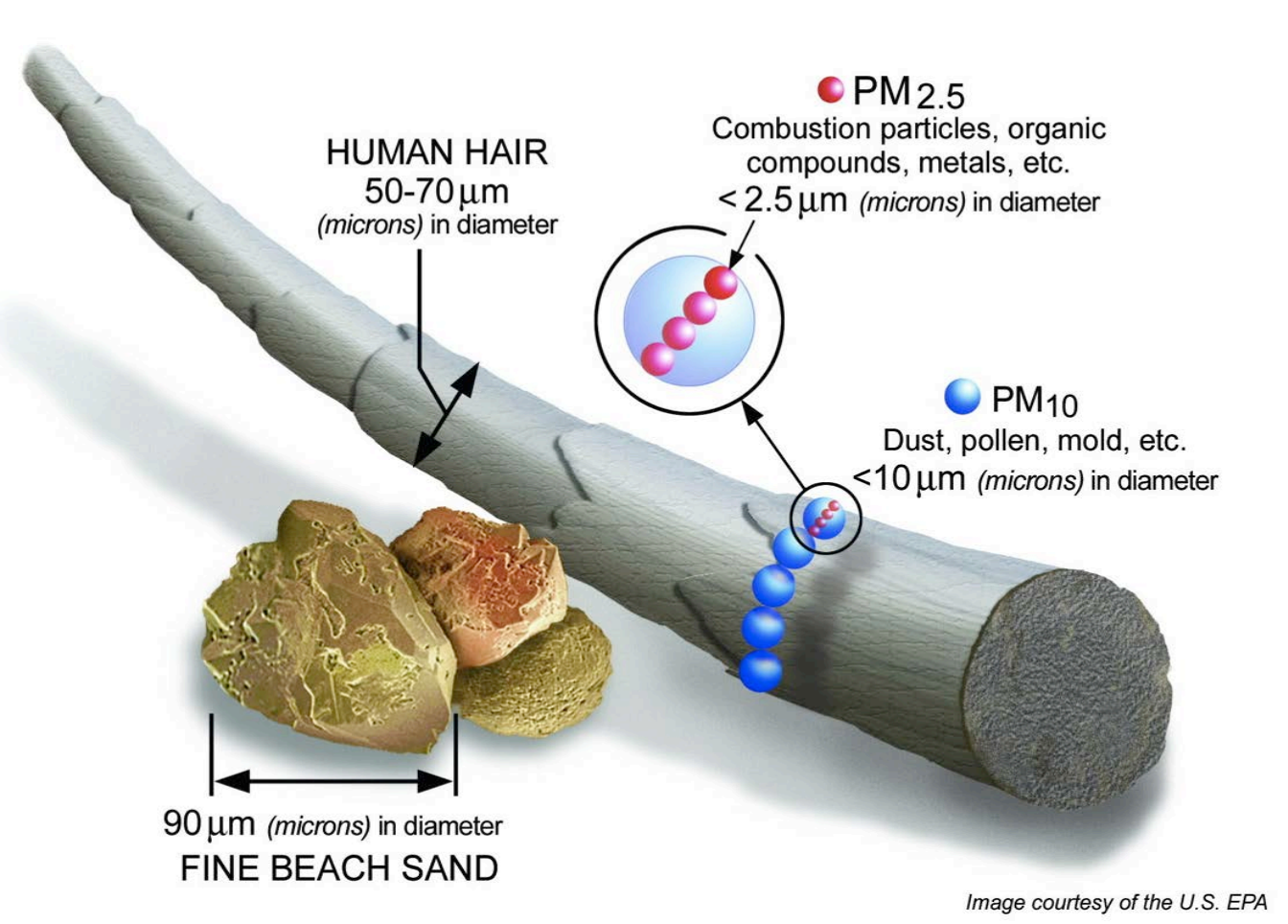
Health Impacts

- Preventable Hospitalizations Statewide & in SBC
  - *Hypertension (39.3 in SB; 32.7 in CA)
  - *Asthma (83.7 in SB; 82.5 in CA)
  - *COPD (135.6 in SB; 127.7 in CA)
  - **Pediatric Asthma (**100.1 in SB; 77.6 in CA**)

* Number of hospitalizations per 100,000 persons aged 18 and older.
** Number of hospitalizations per 100,000 persons aged 2-17.
[1]Source: Health Risk Assessment for the BNSF Railway San Bernardino Railyard, CARB 2008.
[2]Source: OSHPD, Patient Discharge Data, 1999-2008, Version 3.1

Particles in Diesel Exhaust

- Carbon particles (soot)
- Fine particles (< 2.5 microns)
- Ultrafine Particles*
- Lab rats & human embryonic kidney cells
- Cancer risk



Health Issues of Concern: Current Research-Evidence

» Fine particles in high concentrations near busy roads:

- Oxidative & nitrosative stress in airways leading to inflammation
- Correlated with amount of carbon in airway macrophages of children

Health Issues of Concern: Current Evidence

- Epidemiologic evidence is gradually mounting on the adverse health effects associated with proximity to traffic
  - Asthma occurrence and exacerbation, lung function deficits, and respiratory conditions in children
  - Airway inflammation
  - Hospitalizations

Residential Proximity to the Goods Movement System

- **THE BIG QUESTIONS**
  - Are the Californians who live near ports, rail yards, and along high traffic corridors subsidizing the goods movement sector with their health?
  - Are low-income, minority communities disproportionately impacted?

California Air Resources Board. Decemeber 2005. Emission reduction strategies. In: Draft Emission Reduction Plan for Ports and International Goods Movement. Sacramento, CA:California Air Resources Board, III-1–III-60. http://www.arb.ca.gov/planning/gmerp/dec1plan/chapter3.pdf [accessed 17 April 2013].

California Air Resources Board Studies

- **Statewide Railroad Pollution Reduction Agreement** (SRPRA)
  - Series of risk assessments in major railyards statewide
  - 18 railyards assessed across California

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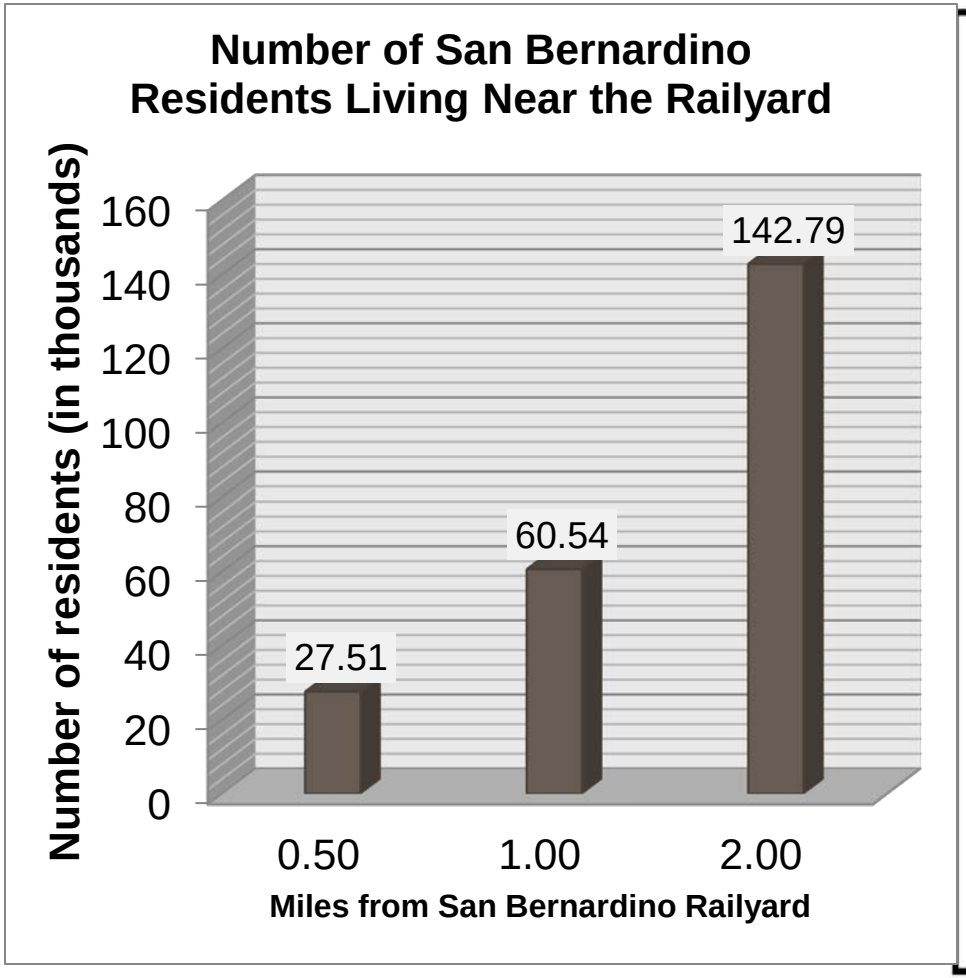
The San Bernardino Railyard



The Study

Project ENRRICH a community based participatory research study, was developed by researchers at Loma Linda University (LLU) in partnership with the Center for Community Action and Environmental Justice (CCAEJ) to understand how proximity to a freight railyard impacts health of surrounding community members (both adult and children).

1. **Population-based Cancer assessment** (based on available cancer registry data)
2. **Population-based community respiratory health assessment**
3. **Elementary school respiratory health screening**

Ongoing commitment to seeking options for mitigation

POPULATION-BASED CANCER SUBSTUDY

Purpose

- To evaluate all and site-specific cancer occurrence against expected counts for invasive cancers in residential areas surrounding the SBR
  - Assessment of three hierarchal air pollution exposure areas modeled on excess diesel exhaust emissions from the SBR: High, Moderate, Low.

Cancer Sub-study Methods

- Non-concurrent cohort study by extracting annual counts of observed new cancers for 1996-2008 in the study area from the California Cancer Registry (CCR) confidential database for all invasive cancers combined.
- Observed new cases were identified by residence address at diagnosis in 16 contiguous Year 2000 census tracts surrounding the SBR in the City of San Bernardino.
- Analysis adjusts for age, sex, race/ethnicity, and population size

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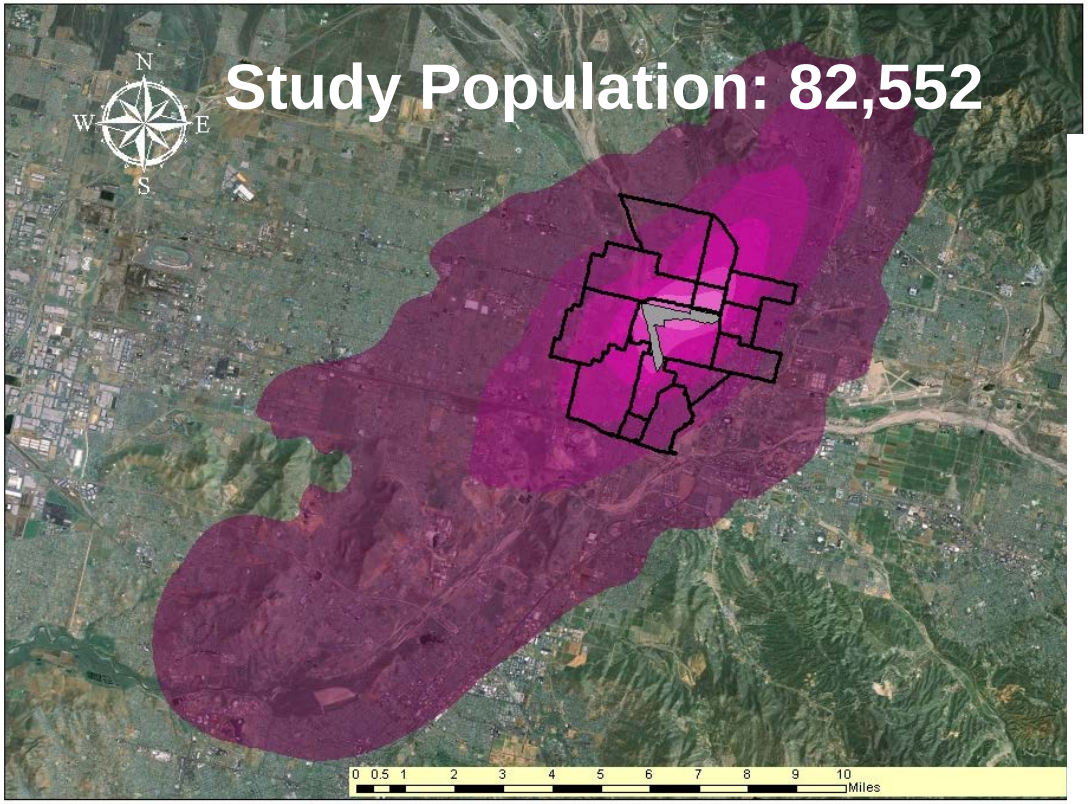
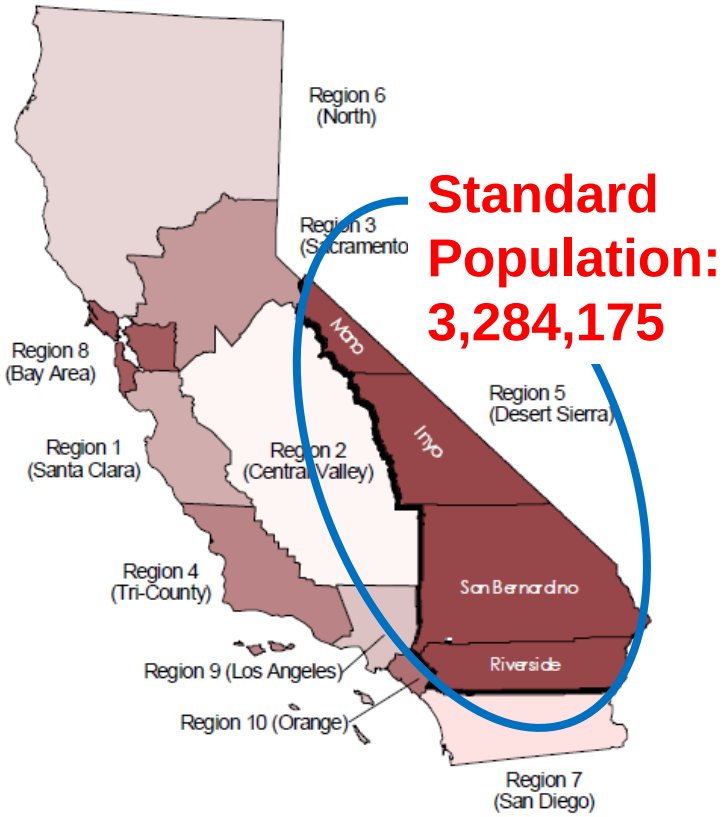
Cancer Sub-study Methods

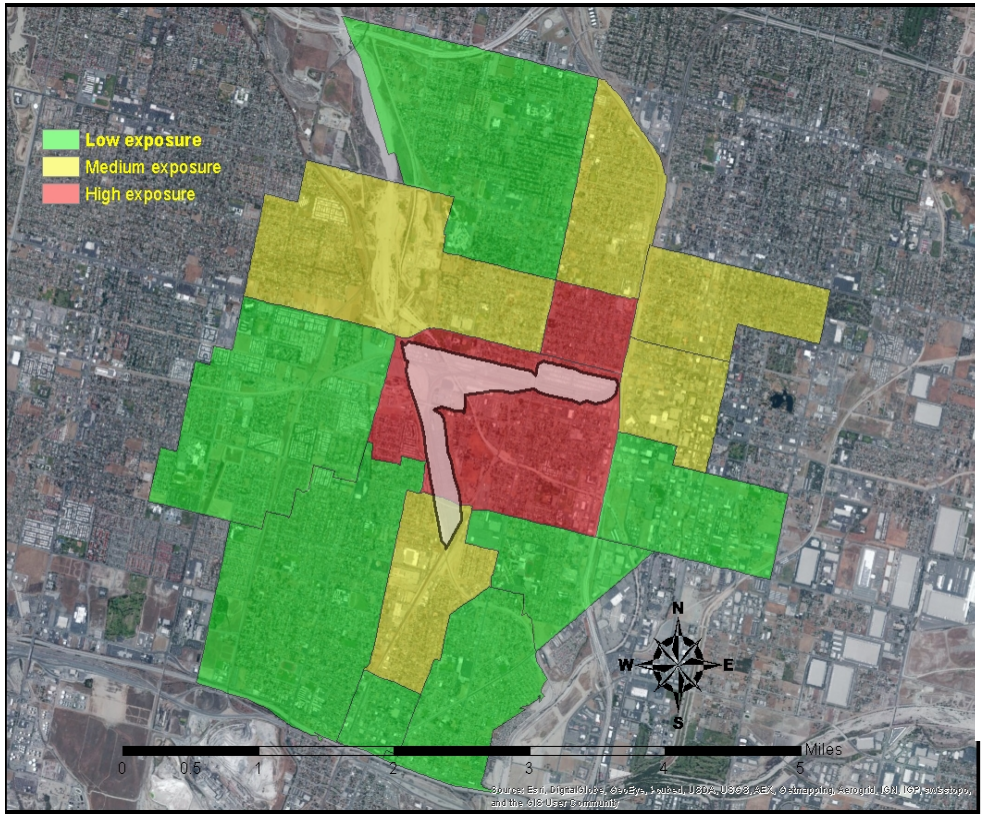


Regional registries forming the California Cancer Registry: Region 5 is highlighted



THE SAN BERNARDINO RAILYARD AND ITS RISK IMPACT ZONES IN RELATION TO THE BOUNDARIES OF THE CENSUS TRACTS ON WHICH THE POPULATION-BASED CANCER ASSESSMENT WAS BASED.

Assignment of Railyard Exposure



Tracts were classified into 3 exposure zones: high, moderate and low, with each representing higher exposure to diesel emissions than the standard population

MAP OF THE SAN BERNARDINO RAILYARD AND ADJACENT CENSUS TRACTS USED IN THE CANCER ASSESSMENT. CENSUS TRACTS ARE COLOR CODED ACCORDING TO THE MODELED DOSE-RELATED RELATED RAILYARD EMISSION EXPOSURE LEVELS: LOW, MEDIUM, AND HIGH.

Cancer Sub-study Results

All Cancers

TABLE 2-2. OBSERVED (O) AND EXPECTED (E) COUNTS, AGE-STANDARDIZED INCIDENT RATIOS (SIR_S) AND 95 PERCENT CONFIDENCE INTERVAL LIMITS (95% CI) FOR SIR_S AMONG ALL CANCERS COMBINED BY SEX AND RACE/ETHNICITY† AND COMBINED FOR 16‡ CENSUS TRACTS (3 RAILYARD EXPOSURE AREAS) COMBINED, 1996-2008.

All Race/Ethnic Groups Combined					Asian/Other†					Non-Hispanic Black					Hispanic					Non-Hispanic White				
Count		SIR	95% CI		Count		SIR	95% CI		Count		SIR	95% CI		Count		SIR	95% CI		Count		SIR	95% CI	
O	E	(O/E)	LL	UL	O	E	(O/E)	LL	UL	O	E	(O/E)	LL	UL	O	E	(O/E)	LL	UL	O	E	(O/E)	LL	UL
										FEMALES														
1,572	1,483.7	**1.06**	1.01	1.11	41	57.6	**0.71**	0.51	0.97	296	283.4	1.04	0.93	1.17	750	689.8	**1.09**	1.01	1.17	485	452.8	1.07	0.98	1.17
										MALES														
1,714	1,515.5	**1.13**	1.08	1.19	45	56.8	0.79	0.58	1.06	333	348.6	0.96	0.86	1.06	797	673.3	**1.18**	1.10	1.27	539	436.7	**1.23**	1.13	1.34
										BOTH SEXES														
3,286	2,999.2	**1.10**	1.06	1.13	86	114.4	**0.75**	0.60	0.93	629	632.1	1.00	0.92	1.08	1,547	1363.2	**1.13**	1.08	1.19	1,024	889.5	**1.15**	1.08	1.22

†Asian/other includes Asia n, Pacific Islander, and mixed race/ethnic groups and persons not classified in the other race /ethnicity categories. NH signifies non-Hispanic ethnicity, regardless of Black and White designation.

‡16 Census tracts combined include the 16 San Bernardino County year 2000 Census tracts in the vicinity of the SBR including tracts 4201-4202, 4401-4402, 4300, 4700-4900, 5500-5700, 5900, 6600-6800, and 7000.

Key Findings: All Cancers

- Statistically significant but modest elevation for both sexes combined, all race/ethnic groups combined
- Statistical elevations:
  - Hispanic females
    - **SIR = 1.09; 95% CI: 1.01-1.17**
  - Hispanic males
    - **SIR = 1.18; 95% CI: 1.10-1.27**
  - Non-Hispanic White females
    - **SIR = 1.07; 95% CI: 0.98-1.17**
  - Non-Hispanic White males
    - **SIR = 1.23; 95% CI: 1.13-1.34**

Key Findings: All Cancers

- Lower than expected cancer counts among Asian/other residents
  - **SIR = 0.75; 95% CI: 0.60-0.93**
- No evidence of risk elevations for non-Hispanic Black residents found
- No clear evidence of a “dose-response” trend across hypothesized low-moderate-high exposure gradient

FEMALES

Cancer Site*	Asian/Other‡ Count O	Count E	SIR (O/E)	95% CI LL	UL	NH Black Count O	Count E	SIR (O/E)	95% CI LL	UL	Hispanic Count O	Count E	SIR (O/E)	95% CI LL	UL	NH White Count O	Count E	SIR (O/E)	95% CI LL	UL
All Sites	41	57.59	**0.71**	0.51	0.97	296	283.44	1.04	0.93	1.17	750	689.85	**1.09**	1.01	1.17	485	452.82	1.07	0.98	1.17
Lung	<5	<5	0.21	-	-	41	39.85	1.03	0.74	1.40	63	65.52	0.96	0.74	1.23	87	64.80	**1.34**	1.08	1.66
Breast	15	18.53	0.81	0.45	1.34	74	85.93	0.86	0.68	1.08	96	73.57	**1.30**	1.06	1.59	136	145.24	0.94	0.79	1.11
CRC	<5	<5	0.62	-	-	40	38.70	1.03	0.74	1.41	215	212.10	1.01	0.88	1.16	54	50.63	1.07	0.80	1.39
Pancreas	0	1.20	N/A	-	-	11	9.93	1.11	0.55	1.99	14	16.53	0.85	0.46	1.42	9	11.35	0.79	0.36	1.51
NHL	<5	<5	0.45	-	-	6	8.64	0.69	0.25	1.52	33	35.35	0.93	0.64	1.31	16	17.40	0.92	0.52	1.50

MALES

All Sites	45	56.85	0.79	0.58	1.06	333	348.64	0.96	0.86	1.06	797	673.32	**1.18**	1.10	1.27	539	436.72	**1.23**	1.13	1.34
Lung	<5	<5	0.58	-	-	49	56.37	0.87	0.64	1.15	41	48.66	0.84	0.60	1.14	86	62.71	**1.37**	1.10	1.69
CRC	<5	<5	0.15	-	-	34	35.50	0.96	0.66	1.34	208	191.75	1.08	0.94	1.24	57	47.08	1.21	0.92	1.57
Prostate	12	17.36	0.69	0.36	1.21	120	137.24	0.87	0.72	1.05	57	62.76	0.91	0.69	1.18	122	123.59	0.99	0.82	1.18
Pancreas	<5	<5	1.82	-	-	12	8.14	1.47	0.76	2.58	17	19.16	0.89	0.52	1.42	11	9.86	1.12	0.55	2.00
NHL	<5	<5	0.39	-	-	6	10.03	0.60	0.22	1.31	28	30.77	0.91	0.60	1.32	16	18.63	0.86	0.49	1.40

SEXES COMBINED

All Sites	86	114.43	**0.75**	0.60	0.93	629	632.09	1.00	0.92	1.08	1,547	1,363.2	**1.13**	1.08	1.19	1,024	889.54	**1.15**	1.08	1.22
Lung	5	11.57	0.43	0.14	1.02	90	99.41	0.91	0.73	1.11	104	112.48	0.92	0.76	1.12	173	127.51	**1.36**	1.16	1.57
CRC	5	13.13	**0.38**	0.12	0.90	74	74.20	1.00	0.78	1.25	153	136.33	1.12	0.95	1.32	111	97.70	1.14	0.93	1.37
Pancreas	<5	<5	0.87	-	-	23	18.08	1.27	0.81	1.91	31	35.70	0.87	0.59	1.23	19	21.21	0.90	0.54	1.40
NHL	<5	<5	0.41	-	-	12	18.67	0.64	0.33	1.13	52	66.13	0.79	0.59	1.03	47	52.40	0.90	0.66	1.19

†16 Census tracts combined include the 16 San Bernardino County year 2000 Census tracts in the vicinity of the BNSF railyard.

‡ Asian/Other includes Asian, Pacific Islander, and mixed race/ethnic groups and persons not classified in the other race/ethnicity categories. NH signifies non-Hispanic ethnicity, regardless of Black and White designation.

*Lung signifies cancer originating in the lung and bronchus, CCR signifies colorectal cancer, NHL is non-Hodgkin"s lymphoma, and Nasophx signifies nasopharyngeal carcinoma.

<5 signifies observed or expected counts fewer than 5. The precise numbers are not revealed to preserve the identities and health status for individuals. N/A SIR is undefined and not available because observed count is zero.

Statistically Significant SIRs indicated in bold.

Key Findings: Cancer Types

All 16 contiguous Census Tracts combined:

- Among Hispanics, statistical elevations for:
  - Breast cancer (SIR = 1.30; 95% CI: 1.06-1.59)
  - All cancer sites combined
    - Females (SIR = 1.09; 95% CI: 1.01-1.17)
    - Males (SIR = 1.18; 95% CI: 1.10-1.27)
- Statistical elevations for lung/bronchus cancer among non-Hispanic Whites:
  - Females (SIR = 1.34; 95% CI: 1.08-1.66)
  - Males (SIR = 1.37; 95% CI: 1.10-1.69)
- Fewer than expected counts for all cancer sites combined among females
- Markedly lower than expected counts of colorectal cancer among Asian/other residents

Exposure →	Railyard High					Railyard Moderate					Railyard Low				
	Count		SIR	95% CI		Count		SIR	95% CI		Count		SIR	95% CI	
Cancer Site¥	O	E	(O/E)	LL	UL	O	E	(O/E)	LL	UL	O	E	(O/E)	LL	UL
FEMALES															
All Sites	149	135.43	1.10	0.93	1.29	489	738.01	**0.66**	0.61	0.72	934	943.30	0.99	0.93	1.06
Lung	20	11.22	**1.78**	1.09	2.76	52	54.04	0.96	0.72	1.26	98	103.73	0.94	0.77	1.15
Breast	38	39.56	0.96	0.68	1.32	142	148.53	0.96	0.81	1.13	253	287.78	**0.88**	0.77	0.99
CRC	15	13.26	1.13	0.63	1.87	47	55.30	0.85	0.62	1.13	93	101.28	0.92	0.74	1.13
Pancreas	6	3.76	1.60	0.57	3.50	9	14.75	0.61	0.28	1.16	21	26.13	0.80	0.50	1.23
NHL	6	5.88	1.02	0.37	2.24	16	20.57	0.78	0.44	1.27	30	37.50	0.80	0.54	1.14
MALES															
All Sites	132	138.91	0.95	0.80	1.13	545	751.71	**0.73**	0.67	0.79	1,037	953.25	**1.09**	1.02	1.16
Lung	9	14.70	0.61	0.28	1.17	73	68.52	1.07	0.83	1.34	120	120.11	1.00	0.83	1.19
CRC	21	14.60	1.44	0.89	2.20	70	58.54	1.20	0.93	1.51	97	101.03	0.96	0.78	1.17
Prostate	33	42.15	0.78	0.54	1.10	154	179.87	0.86	0.73	1.00	290	308.44	0.94	0.84	1.05
Pancreas	<5	<5	1.24	-	-	17	12.86	1.32	0.77	2.12	18	22.06	0.82	0.48	1.29
NHL	5	6.95	0.72	0.23	1.69	14	23.57	0.59	0.32	1.00	37	41.43	0.89	0.63	1.23
SEXES COMBINED															
All Sites	281	274.35	1.02	0.91	1.15	1,034	1,489.71	**0.69**	0.65	0.74	1,971	1,896.56	1.04	0.99	1.09
Lung	29	25.92	1.12	0.75	1.61	125	122.56	1.02	0.85	1.22	221	223.84	0.99	0.86	1.13
CRC	36	27.85	1.29	0.90	1.79	117	113.84	1.03	0.85	1.23	190	202.31	0.94	0.81	1.08
Pancreas	10	6.98	1.43	0.68	2.65	26	27.61	0.94	0.61	1.38	39	48.19	0.81	0.58	1.11
NHL	11	12.83	0.86	0.43	1.54	30	44.14	**0.68**	0.46	0.97	67	78.92	0.85	0.66	1.08

¥ All Sites represents all cancer types combined, lung signifies cancer originating in the lung or bronchus, CRC signifies colorectal cancer, NHL is non-Hodgkin"s lymphoma.

<5 signifies observed or expected counts fewer than 5. The precise numbers are not revealed to preserve the identities and health status for individuals.
N/A indicates SIR values that are undefined because of zero observed or expected cell counts.
Statistically Significant SIRs indicated in bold.

Key Findings: Cancer Types

- Elevations found for residents in the high-exposure Census Tracts:
  - Statistical excess of lung/bronchus cancer
    - Females (SIR = 1.78; 95% CI: 1.09-2.76)
  - Non-significant elevations for colon/rectum cancer among
    - Females (SIR = 1.13; 95% CI: 0.63-1.87)
    - Males (SIR = 1.44; 95% CI: 0.89-2.20)
- No clear pattern moderate & low tracts
- Results for both sexes combined
  - pattern of non-significant but increasing SIRs across higher → low exposure railyard gradient for:
    - lung
    - colon/rectum
    - and pancreas

  suggestive of a possible dose-response trend

HOUSEHOLD-LEVEL HEALTH ASSESSMENT OF ADULT RESIDENTS

Purpose

- Understand perceptions and challenges among adult residents in the areas surrounding the SBR—qualitative assessment.
- Assess the potential association between residential proximity to the SBR and prevalence of adverse health effects among adult residents—quantitative assessment.

Methods

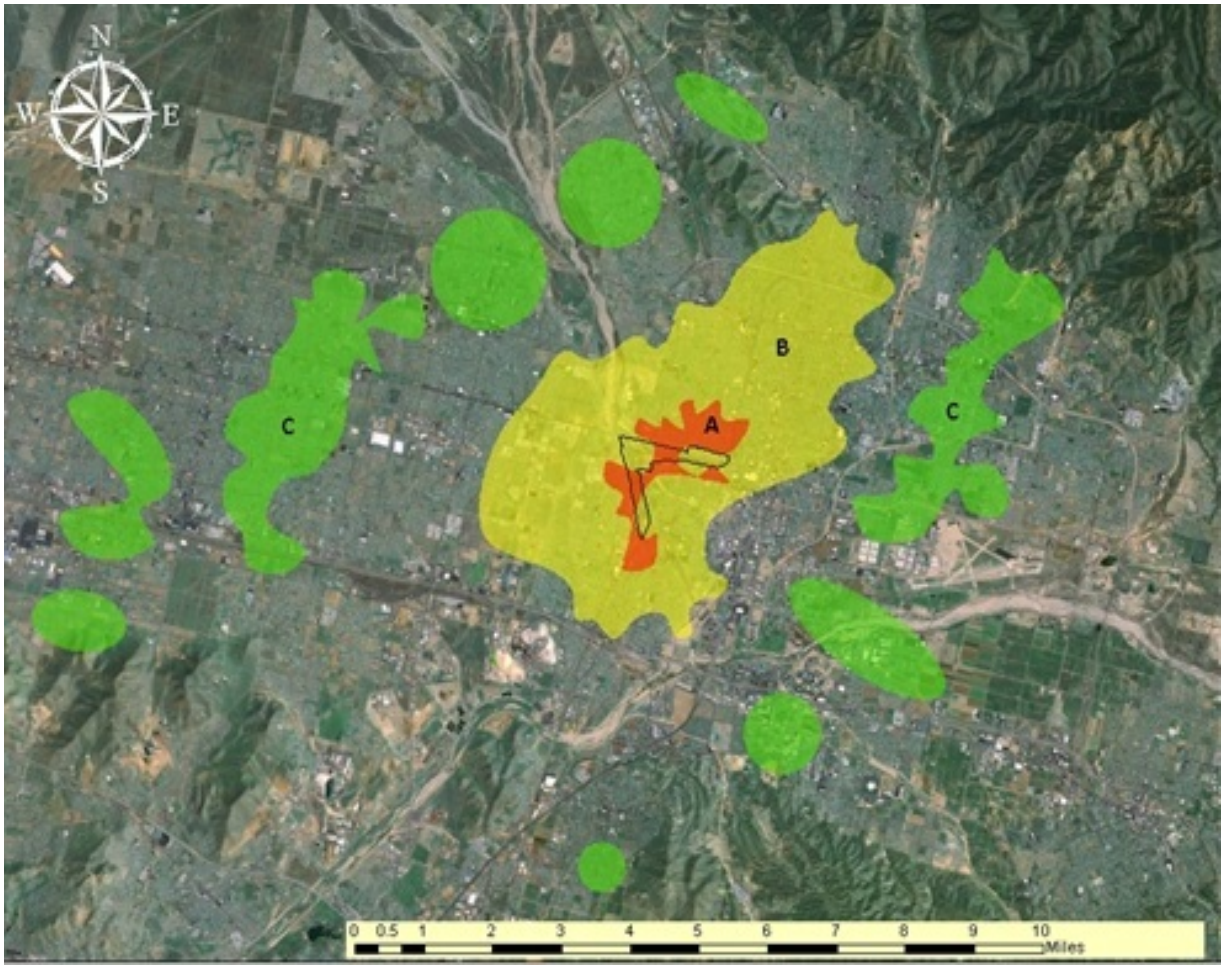
- Qualitative assessment
  - Focus groups (N=5; 53 community members)
  - Key informant interviews (N=12)
- Additional questions included in survey to assess community needs and perceptions
- Responses to questions were coded for recurrent themes and organized into categories

Key Qualitative Findings

- Community members expressed concern for poor air quality in their community, but that other challenges take higher priority (i.e., jobs, providing for families, access to healthcare, law enforcement).
- Participants felt that the railyard has a positive reputation and is highly valued for the jobs and economic growth it provides.
- Railyard was also perceived as a major contributor to the already poor local air quality and especially seen as a major source of noise pollution.

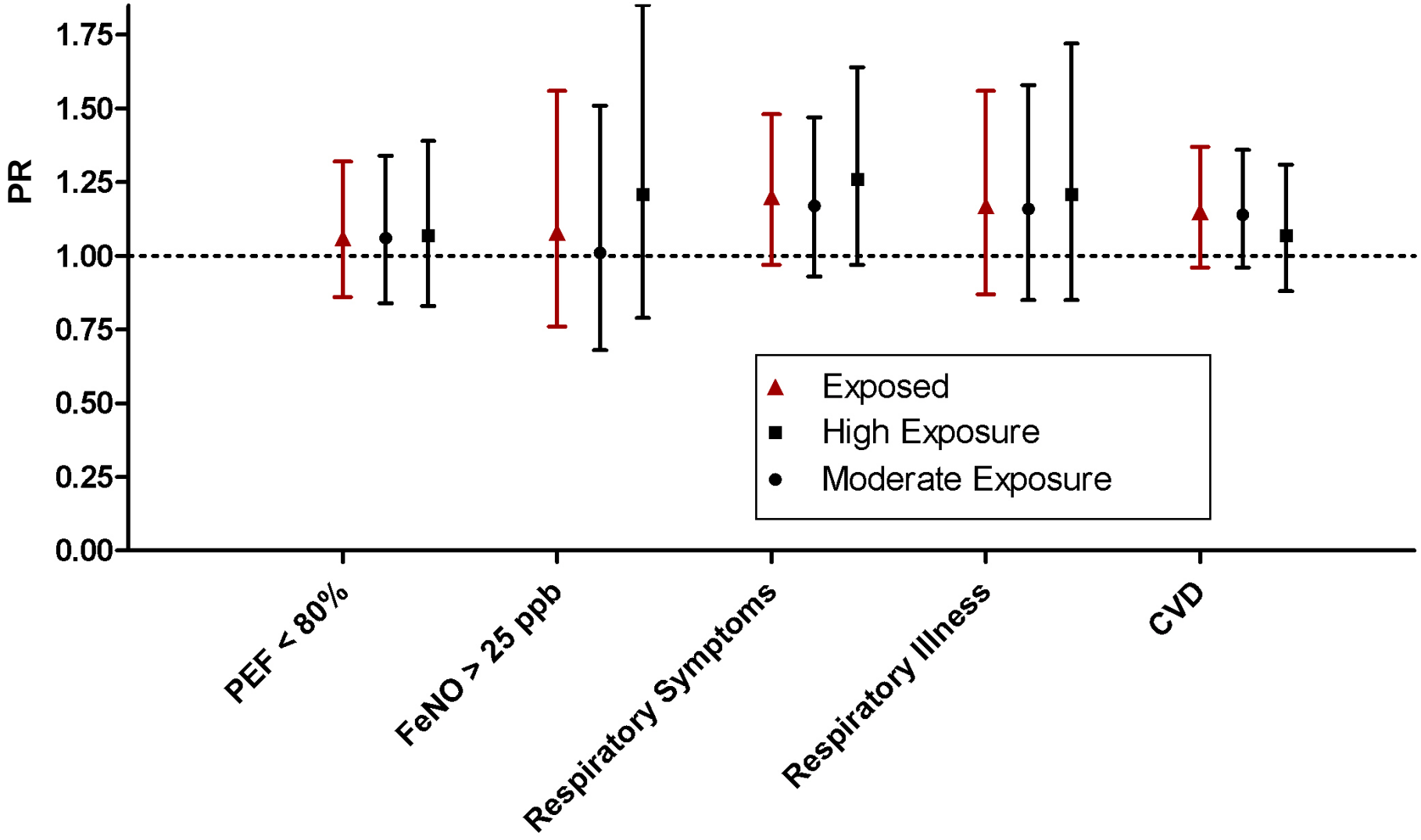
Methods

- Study Design
  - Cross-sectional
  - Data collection: Summer 2011 & Winter-Spring 2012
  - 1000+ households surveyed
- Distance as proxy of exposure to railyard emissions
- Statistical analysis adjusted for relevant confounders:
  - age, sex, race, season, tobacco use, ETS exposure, time spent outdoors, median household income, residential proximity to major roads, total diesel PM from local sources
- Log binomial regression



Map of study area: railyard and the surrounding sampling areas from which households were selected for the field health survey of adult residents: A (high exposure, red); B (moderate exposure, yellow); and C (comparison, background, green). Cross-sectional subject locations are not shown to protect the participants' confidentiality.

Key Quantitative Results



Survey Findings

- Residing in close proximity to railyard is associated with small but detectable effects on prevalence of respiratory and CVD outcomes in adults.
  - Despite its relatively small size (11,500 acres), we detected variations in the prevalence of the outcomes within the REZ.
  - Elevations were higher for prevalence of self-reported symptoms and doctor-diagnosed respiratory conditions than for low PEF and high FeNO (airway inflammation).
  - There was a general trend of increased from the *Moderate* to the *High* exposure regions.
  - The results were not statistically significant, although some of the associations were borderline significant.

SCHOOL-BASED ASSESSMENT OF RESPIRATORY HEALTH

Purpose

- To assess the relationship between pollution density near and further away from a goods movement rail yard and adverse respiratory health effects among nearby schoolchildren in an area already impacted by regional air pollution

School Sub-study Methods

- Cross-sectional design to compare two socio-demographically matched elementary schools in the San Bernardino area
  - School-based respiratory health screenings over the last two weeks of February, 2012 with students from grades K-5. Respiratory testing (PEF and FeNO collected), along with height and weight.
  - Exposed school→500 m downwind from the rail yard
  - Comparison school→7 miles west.

Study area, illustrating the location of the San Bernardino Railyard (SBR), and the two participating elementary schools in relation to the transportation infrastructure (railroads and roadways). The inset map displays the full geographic extent of the impact zones in relation to the study area (rectangle).

School Sub-study Methods

- School district approval
- Educational theatrical play during an assembly at each elementary school

School Sub-study Methods

- Parental consent and questionnaire
- Partner: Arrowhead Regional Medical Center Breathmobile® Program
- Protocol approved by the Loma Linda University Institutional Review Board (IRB), Human Research Participant Protection (HRPP) Program.

School Sub-study Methods

- The association of school location with the respiratory health outcomes measures was studied using log-binomial, linear, and logistic regression models
  - FE_{NO} values: elevated inflammation (≥20 ppb) *vs*. normal.
  - PEF values: decreased lung function (< 80% of predicted value) *vs*. normal.
- Adjusted for potential confounders including: individual/residential, community level and other sources of air pollution (ie. traffic and local sources not railyard related)

Results

Basic characteristics and exposures of participating children

Characteristic	All subjects (n = 877)	By School of Enrollment	
		Exposure School (n = 435)	Comparison School (n = 442)
Age, yr, mean ± SD	7.96 ± 1.8	7.97 ± 1.8	7.95 ± 1.8
Race/Ethnicity, n (%)			
Non-Hispanic White	42 (4.8)	19 (4.4)	23 (5.2)
Hispanic	732 (83.4)	356 (81.8)	376 (85.1)
African American	48 (5.5)	32 (7.4)	16 (3.6)
Other	55 (6.3)	28 (6.4)	27 (6.1)
Gender, male, n (%)	414 (47.2)	201 (46.2)	213 (48.2)
Grade, n (%)			
Kindergarten	128 (14.6)	74 (17.0)	54 (12.2)
1st	145 (16.5)	57 (13.1)	88 (19.9)
2nd	161 (18.4)	77 (17.7)	84 (19.0)
3rd	139 (15.9)	71 (16.3)	68 (15.4)
4th	156 (17.8)	81 (18.6)	75 (17.0)
5th	148 (16.9)	75 (17.2)	73 (16.5)
BMI, n (%)			
Underweight (<18.5 kg/m2)	39 (4.5)	28 (6.4)	11 (2.5)
Normal (18.5 - 24.9 kg/m2)	481 (54.8)	233 (53.6)	248 (56.1)
Overweight (25.0 - 29.9 kg/m2)	144 (16.4)	71 (16.3)	73 (16.5)
Obese (>30 kg/m2)	213 (24.3)	103 (23.7)	110 (24.9)

Basic characteristics and exposures of participating children

Characteristic	All subjects (n = 877)	By School of Enrollment: Exposure School (n = 435)	By School of Enrollment: Comparison School (n = 442)
Time spent outdoors, n (%)			
< 12 hours	359 (40.9)	183 (42.1)	176 (39.8)
12 – 24 hours	368 (42.0)	187 (43.0)	181 (41.0)
> 24 hours	150 (17.1)	65 (14.9)	85 (19.2)
Lived with smoker, n (%)	188 (21.4)	103 (23.7)	85 (19.2)
Distance to major road			
< 100 m	295 (33.6)	190 (43.7)	105 (23.8)
100 – 200 m	179 (20.4)	76 (17.5)	103 (23.3)
200 – 300 m	180 (20.5)	80 (18.4)	100 (22.6)
> 300 m	223 (25.4)	89 (20.5)	134 (30.3)
Median household income, mean ± SD	43,726 ± 13,679	38,755 ± 12,704	48,618 ± 12,826
Diesel PM exposure, kg/day, mean± SD	7.96 ± 1.47	7.73 ± 1.81	8.19 ± 0.98

Low PEF (Peak Expiratory Flow)

- Significant effects seen for airway obstruction measured by PEF among children attending the ES:
  - PR = **1.59**, 95% CI:1.19, 2.12 (log binomial).
  - β = **-14.9**, 95% CI: -22.2, -7.58 (linear)
- Among children who had lived 6 months+ at their current address:
  - PR = **1.41**, 95% CI: 1.03-1.92 (log binomial).
  - β = **-13.0**, 95% CI: -20.8, -5.20 (linear)

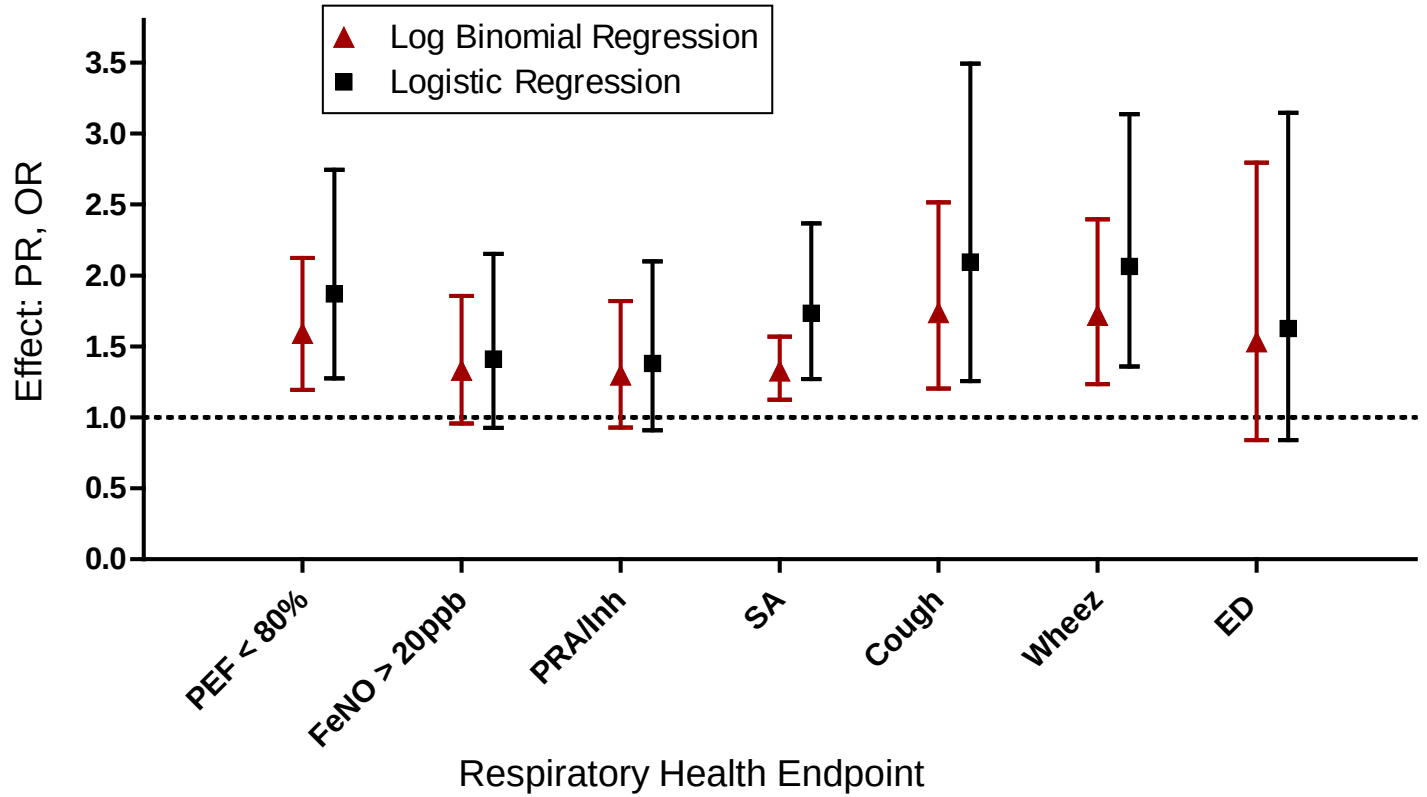
FeNO--Airway Inflammation

- Children at the ES exhibited higher airway inflammation measured by FE_{NO}
  - PR = 1.33, 95% CI:0.96, 1.86 (log binomial).
- No association through linear regression
  - β = -0.01, 95% CI:-0.13, 0.11
- Among children who had lived 6 months+ at their current address findings were stronger
  - PR=**1.44**, 95% CI: 1.02, 2.02.
  - An elevation but no significant association found through linear regression
    - β = 0.03, 95% CI: -0.10, 0.16

Respiratory Outcomes/Symptoms

- Parent-reported asthma/inhaler use
  - PR = 1.30, 95% CI:0.93-1.82
- Parent-reported asthma/PEF<80%/FeNO>20ppb
  - PR = **1.33**, 95% CI:1.12-1.57
- Cough
  - PR = **1.74**, 95% CI:1.20-2.51
- Wheezing
  - PR = **1.72**, 95% CI:1.23-2.39
- Parent-reported ED visit within last year
  - PR = 1.53, 95% CI:0.84-2.79

LB and LR Modeling Results (Prevalence Ratios and Odds Ratios, 95% Confidence Intervals) of Children at the Exposure Elementary School Experiencing Adverse Respiratory Health Outcomes in Contrast With the Comparison Elementary School



Model = *school, age, gender, race, ETS, time spent outdoors, median household income, proximity to nearest major road, total diesel* $PM_{2.5}$

Key Findings

- After adjusting for relevant confounders, a higher prevalence of adverse respiratory health outcomes in the school near the rail yard remained.
  - A 41% increase in prevalence of low PEF, and a 33% increase in the PR with respect to lung inflammation for children living near the rail yard compared to those farther away
- The pattern of adverse effects suggests that proximity to the rail yard might enhance the respiratory risk for children attending school nearby.

OVERALL DISCUSSION

- This is the first direct investigation on the concerns about diesel exhaust's health impacts on adults and children residing near a goods movement intermodal railyard.
- Cancer results
  - Challenging due to multifactorial nature of cancer etiology
  - There were statistically significant results for **all cancers** combined, both sexes combined and all race ethnicities combined
  - The magnitude of identified risks was moderate and while statistically significant.
  - We found statistical excess of lung/bronchus cancer in females and non statistically elevations for colon/rectum cancer for males and females in the high exposure area.
  - We found significant elevations for breast cancer among Hispanic females across all regions combined.
  - There were statistical elevations in Hispanic and non Hispanic white male residents for all cancers, without a clear dose response pattern with proximity to SBR

- Through screening we identified a non-trivial number of children exhibiting reduced lung volume and increased airway inflammation, potentially indicative of undiagnosed respiratory problems; self report measures confirmed these results– all were in the direction of increased risk

- Results for adults were in the same direction (elevations) but non-significant; small but detectable effects on respiratory and cardiovascular outcomes
- While results are not as clear as children results, they are trending constantly in the same direction, especially if we combine zone A+B– both in close proximity to the railyard

Limitations

- Cause-effect relationship cannot be established (cross-sectional design)
- In the children sample school location, rather than actual personal exposure measurements, was used as a surrogate of exposure
- Difficult to isolate the exposures to on-site emissions given the presence of other off-site sources of pollution in the community aside from the railyard
- Residential proximity
  - Subjects' street address as surrogate measure for diesel exhaust concentrations = potential for misclassification of railyard related exposure
- Some endpoints: Self-reported

OVERALL CONCLUSION

- The results from this study support the hypothesis that proximity to a major goods movement rail yard impacts the respiratory health of children and adults, **even in an area already afflicted by notoriously poor air quality.**
- These results taken together weigh even stronger as we adjusted for a large number of relevant confounders and for the adults collected data in both seasons– the summer or high burden season and the winter with generally speaking much better overall air quality.
  - **Nevertheless we found modest to moderate elevations across all health endpoints**

- Against the odds of already poor air quality, the question if a railyard posits significant additional risk was a challenging one.
  - In principle however, the contribution of the additional community burden of >20 tons of diesel PM a year emitted by the railyard points to negative health outcomes
  - In addition: emerging published evidence on the effects of diesel PM; the biological plausibility of the results; and the findings from the CARB HRA Report (modeled data) present a pattern of converging findings.
- **Added to all this, our results presented here further point to increased health risks experienced by the community located next to the SBR**

Implications

- Expansion of the goods movement sector
- EJ--Disproportionate exposures
  - The majority of children attending the schools in our study are from low income, minority households as are their families, who live residences close to the school– they too are generally low income, minority residents
  - Chronic psychosocial stress may enhance susceptibility to environmental hazards
- Further policy development and mitigation plans in line with the existing State emission reduction agendas are suggested.

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