

# **Proximity to Oil Refineries and Risk of Cancer: A Population-Based Analysis**

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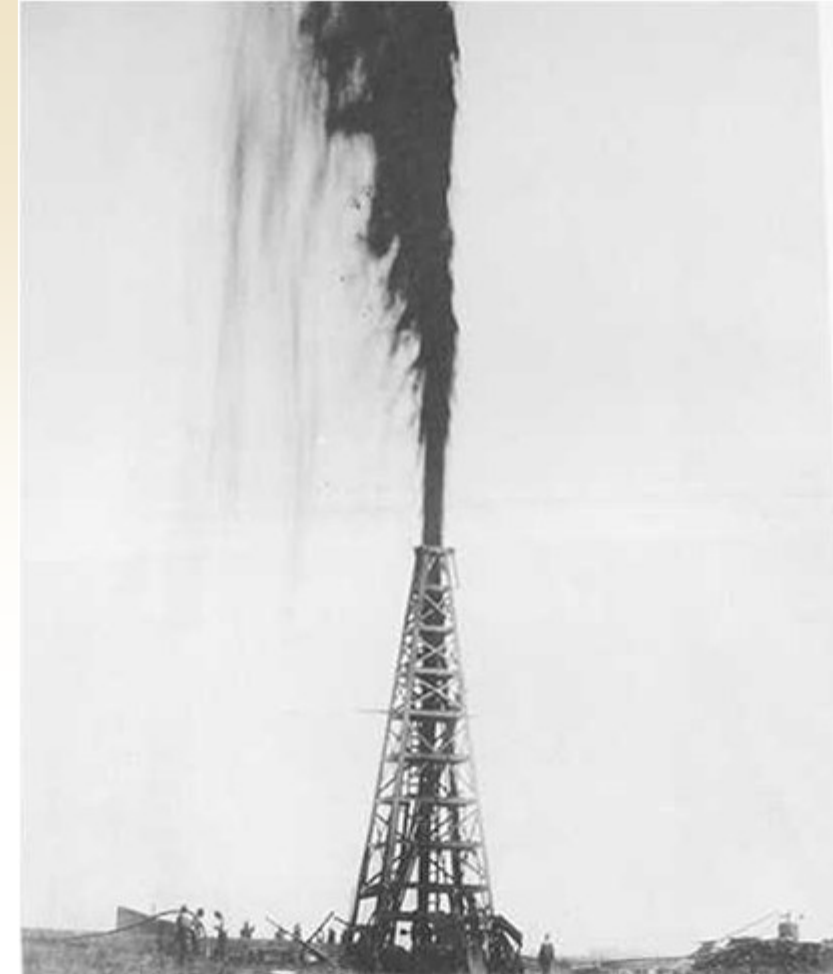
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# Disclosures

- Stephen B. Williams
  - Photocure, Taris, UroToday (Consultant)
  - Janssen (Travel)
- Remaining authors
  - Nothing to disclose

# Background

- Prostate is the second most common cancer in men
- Bladder cancer is the sixth most common cancer diagnosed in the US
- Aromatic amines such as benzenes increase the risk of cancer
- Oil refineries are associated with exposure to aromatic amines



# Background

*Int J Environ Health Res.* 2013;23(4):342-51. doi: 10.1080/09603123.2012.733938. Epub 2012 Oct 16.  
**Cancer morbidity of residents living near an oil refinery plant in North-West Italy.**  
Salerno C<sup>1</sup>, Berchiella P, Palin LA, Vanihaecht K, Panella M.

*J Occup Environ Med.* 2015 Jan;57(1):68-72. doi: 10.1097/JOM.0000000000000301.

## Kidney cancer risk in oil refining in Finland: a nested case-referent study.

- Cancer risk has long been a concern for those working and living around oil refineries

*Coll Antropol.* 2011 Jun;35(2):341-50.

## Cancer incidence in a population living near a petrochemical facility and oil refinery.

Bulat P<sup>1</sup>, Ivić ML, Jovanović MB, Petrović SD, Miljus D, Todorović T, Miladinov-Mikov MM, Bogdanović M.

*Environ Health Perspect.* 1993 Dec;101 Suppl 6:77-84.

## A 39-year follow-up of the U.K. oil refinery and distribution center studies: results for kidney cancer and leukemia.

Rushion L<sup>1</sup>.

*Regul Toxicol Pharmacol.* 2000 Aug;32(1):78-88.

## A critical review of cancer epidemiology in the petroleum industry, with a meta-analysis of a combined database of more than 350,000 workers.

Wong O<sup>1</sup>, Raabe GK.

*Med Lav.* 2019 Feb 22;110(1):3-10. doi: 10.23749/mdl.v110i1.7842.  
**Cancer risk in oil refinery workers: a pooled mortality study in Italy.**  
Bonzini M<sup>1</sup>, Grillo P, Consonni D, Cacace R, Ancona G, Forastiere F, Cocco PL, Satta G, Boldori L, Carugno M, Pesatori CA.

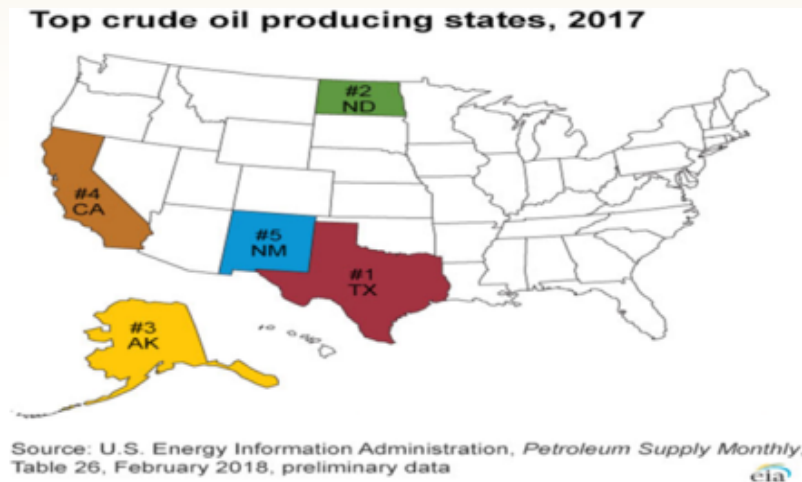
*Environ Health.* 2017 Sep 26;16(1):101. doi: 10.1186/s12940-017-0309-2.

## Lung cancer mortality of residents living near petrochemical industrial complexes: a meta-analysis.

Lin CK<sup>1</sup>, Hung HY<sup>2</sup>, Christiani DC<sup>1,3</sup>, Forastiere F<sup>4</sup>, Lin RT<sup>5</sup>.

# Background

- Petroleum refining in the United States in 2013 produced 18.9 million barrels per day of refined petroleum products, more than any other country
- Texas Ranks #1



Largest petroleum refineries in the United States

Rank	Refinery	Barrels/Day	Owner	State
1	Port Arthur Refinery	603,000	Saudi Aramco	TX
2	Galveston Bay Refinery	571,000	Marathon Petroleum	TX
3	Baytown Refinery	560,500	Exxon Mobil	TX
4	Garyville Refinery	556,000	Marathon Petroleum	LA
5	Baton Rouge Refinery	502,500	Exxon Mobil	LA
6	Lake Charles Refinery	418,000	CITGO	LA
7	Whiting Refinery	413,500	BP	IN
8	Beaumont Refinery	365,644	Exxon Mobil	TX
9	Pascagoula Refinery	352,000	Chevron	MS
10	Wood River Refinery	336,000	WRB Refining	IL

# Objective

To determine the incidence of prostate and bladder cancer in the State of Texas, which is home to the largest number of oil refineries in the United States



# Methods – Data Source

## Texas Cancer Registry

- Collects data on cancer cases in Texas
- Patients (age>20 years) diagnosed with bladder cancer from 2001-2014 were included

## Texas Medicare Database

- Obtain incidence of any fracture diagnosis



- Ascertain overall population size in Texas
- Age, sex, and race distributions



- Smoking rates
- Atmospheric particulate matter (PM2.5) level
- Education and Income



- Identify oil refineries and oil wells

# Methods – Variables

## Proximity to Oil Refinery

- 28 active oil refineries in Texas
- Distance from patient's residential ZIP code to the nearest refinery

## Covariates

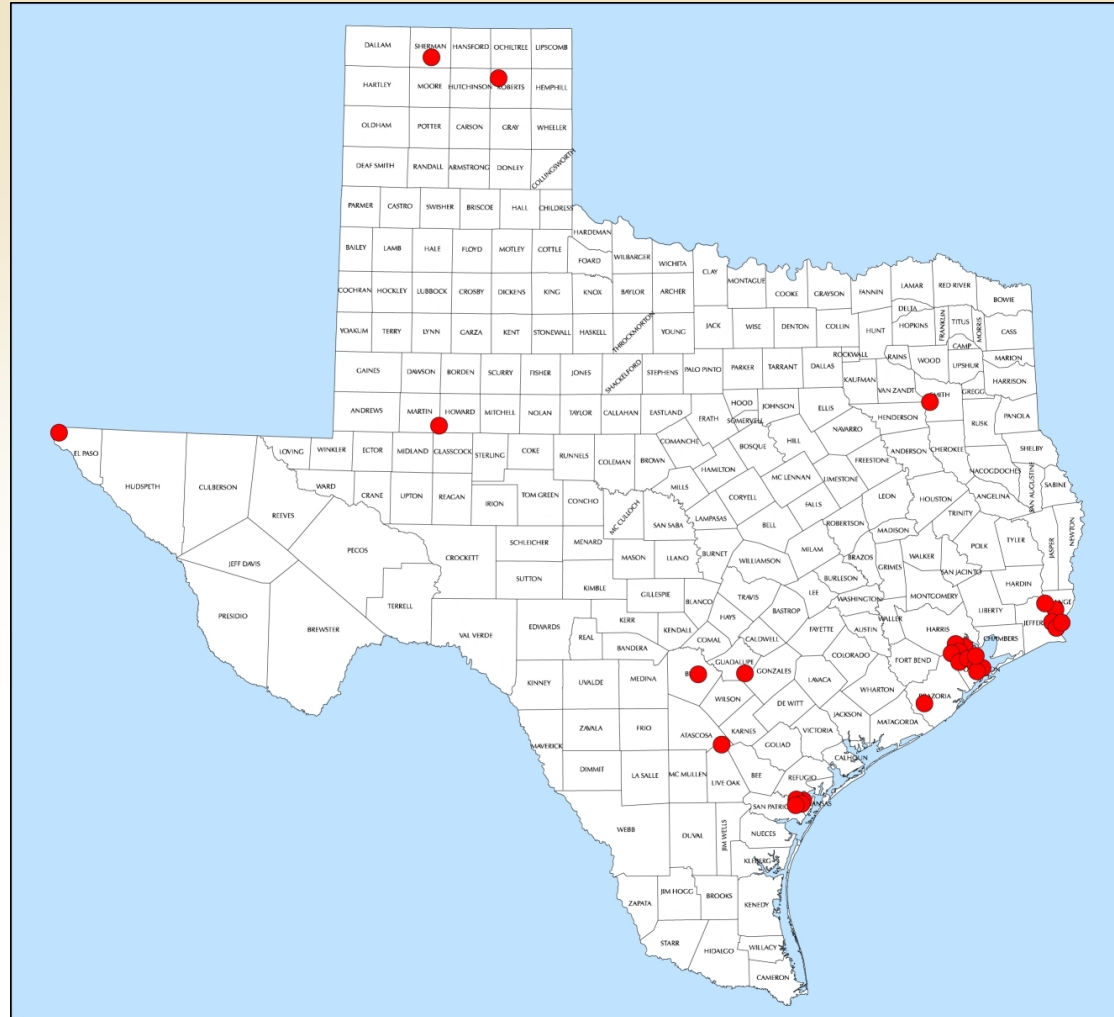
- ZIP code level variables
  - Age – proportion of people with age category
  - Sex – proportion of male/female
  - Race – proportion of white/blacks/others
  - Education and Income- quartiles
- County level variables
  - Smoking rate – proportion of smokers
  - PM 2.5 – high averages of fine particulates (particles 2.5 microns or less in size) from the air in Texas metropolitan areas
  - Oil wells

## Control

- Any fracture diagnosis used as negative control outcome



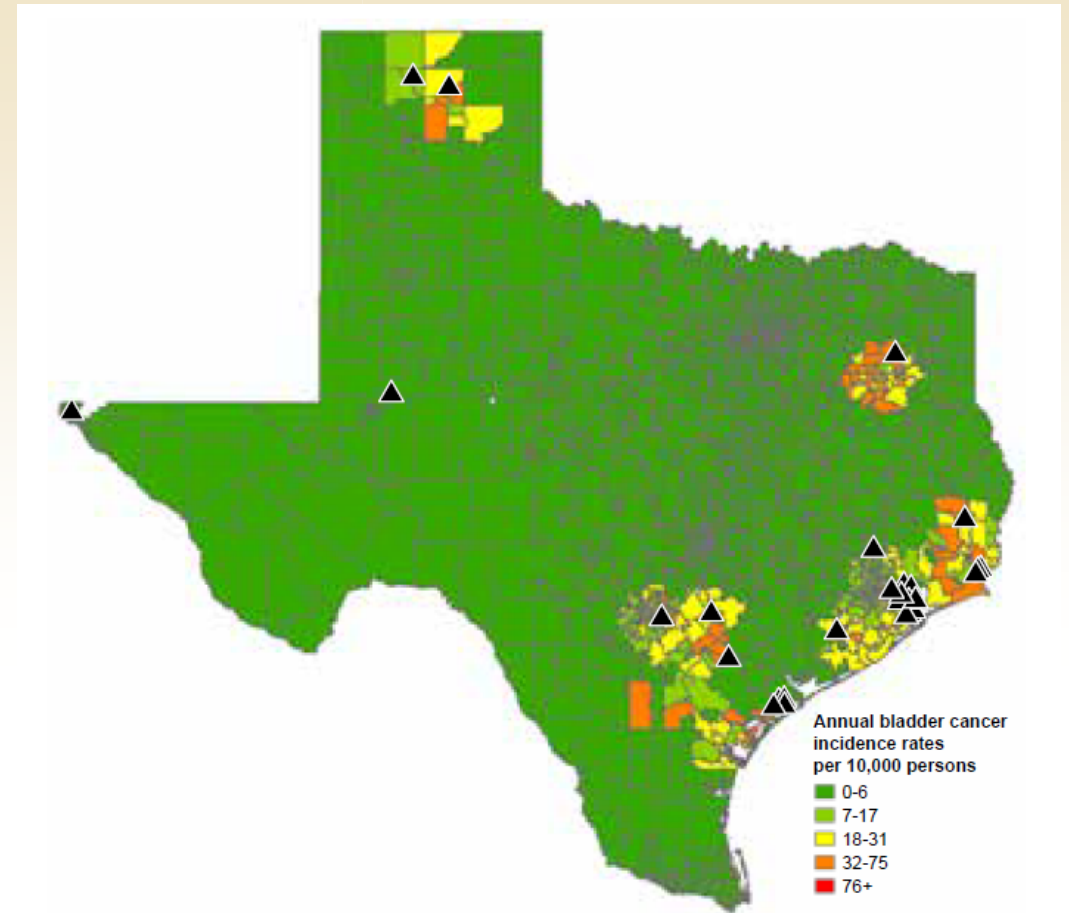
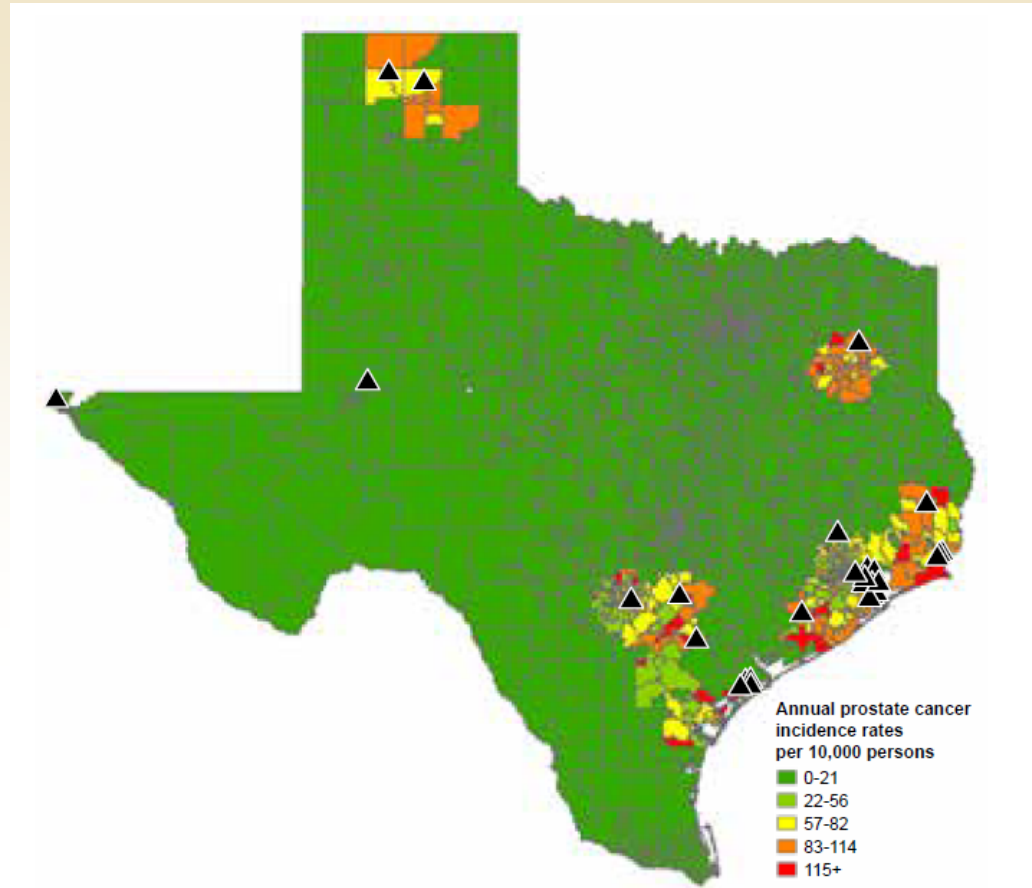
# Methods – 28 Oil Refineries



# Methods – Statistical Analysis

- All analyses were conducted at ZIP code level
- Descriptive statistics were used to determine incidence of prostate and bladder cancer with proximity to oil refineries
- A Zero-inflated Poisson regression model was used to describe the impact of proximity to oil refineries and cancer incidence
  - Outcome = prostate and bladder cancer rate
    - Control= fracture diagnoses
  - Independent variable = proximity to oil refinery
  - Covariates = age, gender, race, smoking and PM2.5

# Results – Heat Maps for Prostate and Bladder Cancer Rate in Texas (Patient/ 10,000 Persons)



# Results- Demographical Data

Demographical Data	
Total Population in Texas	18,100,000
Living within 30 miles from oil refinery	6,302,265
Total cancer patients	829,774
Cancer patients within 30 miles from oil refinery	283,604
Total Zip codes with cancer patients	441

Demographical Data By Distance To Oil Refinery			
Distance From Oil refinery	0-10 miles	11-20 miles	21-30 miles
Total Population	2,213,854	2,433,988	1,654,423
Sex			
Male	1,089,118	1,188,656	809,518
Female	1,124,736	1,245,321	844,683
Race			
White	1,512,062	1,698,916	1,177,791
Black	376,355	348,002	206,775
Other	325,437	387,002	269,635

\* Population as of 2010 per US Census data

# Results –Cancer Rates

Proximity to Oil Refinery	Population	Rate of Bladder Cancer	Rate of Prostate Cancer	Rate of Fracture
0-10 mile	2,213,854	25.0	191.7	76.2
11-20 mile	2,433,988	23.1	184.4	80.9
21-30 mile	1,654,423	22.8	182.9	56.8

\* All rates per 10,000 individuals

\* For prostate cancer, denominator only included male according to distance from oil refinery

# Results – Adjusted association of proximity to an oil refinery and cancer risk

Distance from Oil Refinery (Miles)	Bladder Cancer	Prostate Cancer	Fracture
0-10 mile	1.12 (1.07-1.17)	1.08 (1.06-1.11)	1.0 (0.97-1.02)
11-20 mile	1.06 (1.02-1.11)	1.07 (1.05-1.10)	0.98 (0.96-1.00)
21-30 mile	Ref	Ref	Ref

\* Adjusted for age, sex, race/ethnicity, income, smoking, oil wells, and PM2.5

\* For prostate cancer, denominator only included male according to distance from oil refinery

# Results – Adjusted association of proximity to oil refinery and bladder cancer risk by stage

Proximity to Oil Refinery	Localized Stage Bladder Cancer	Regional Stage Bladder Cancer	Distant Stage Bladder Cancer
0-10 mile	1.09 (1.03-1.14)	1.05 (0.88-1.25)	1.33 (1.06-1.68)
11-20 mile	1.07 (1.02-1.12)	1.01 (0.85-1.19)	0.99 (0.79-1.25)
21-30 mile	ref	ref	ref

\* Adjusted for age, race, distance, education, income, oil wells, and PM2.5

\*\* Localized includes in situ and localized cancer.

\*\*\* Regional includes regional by direct extension only, regional lymph nodes only, Regional (direct extension and regional lymph nodes) and regional not specified

\*\*\*\* Distant stage includes distant metastasis and/or systemic disease

# Results – Adjusted association of proximity to oil refinery and prostate cancer risk by stage

Proximity to Oil Refinery	Localized Stage Prostate Cancer	Regional Stage Prostate Cancer	Distant Stage Prostate Cancer
0-10 mile	1.09 (1.06-1.12)	1.07 (0.99-1.16)	1.20 (1.06-1.35)
11-20 mile	1.11 (1.09-1.14)	1.13 (1.05-1.21)	0.96 (0.85-1.08)
21-30 mile	Ref	ref	ref

\* Adjusted for age, race, distance, education, income, oil wells, and PM2.5

\*\* Localized includes in situ and localized cancer.

\*\*\* Regional includes regional by direct extension only, regional lymph nodes only, Regional (direct extension and regional lymph nodes) and regional not specified

\*\*\*\* Distant stage includes distant metastasis and/or systemic disease



# Limitations

- Population-based study
  - Cannot infer causality
- Confounding
  - Radiation, cyclophosphamide, and occupational history were not controlled for
  - Some variables, e.g., smoking, oil refineries, and PM2.5, were measured at the county level
  - Unemployment, insurance history not captured
  - Duration and prior residence history not captured
- Size and capacity of oil refineries were not considered in the analysis

# Conclusions

- Proximity to oil refinery was associated with an increased risk of bladder and prostate cancer
- We also observed a significantly increased risk of regional and distant/metastatic disease according to proximity to an oil refinery
- Further research in additional cohorts using individual level data are needed to confirm these findings.

# Thank You!

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