Implementation of a National Spirometry Facility Network for the Coal Workers' Health Surveillance Program (CWHSP)

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HHS/CDC/NIOSH/RHD/SB
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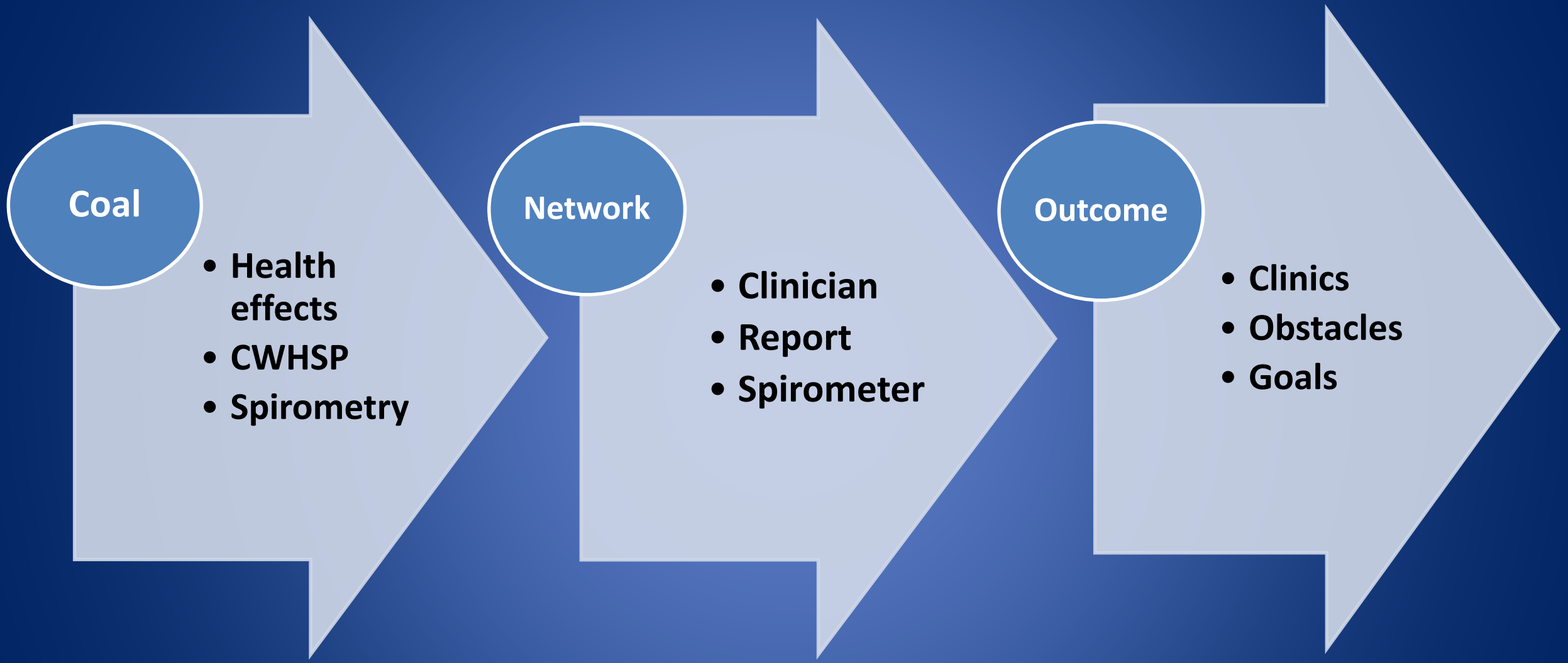
•*The findings and conclusions in this presentation are those of the authors and do not necessarily represent the views of the National Institute of Occupational Safety and Health*

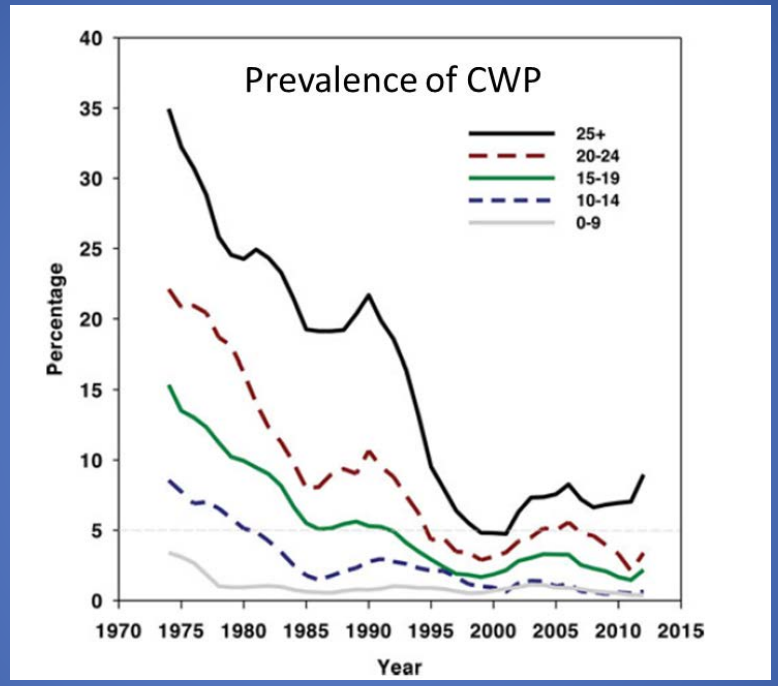

Coal
• Health effects
• CWHSP
• Spirometry
Network
• Clinician
• Report
• Spirometer
Outcome
• Clinics
• Obstacles
• Goals

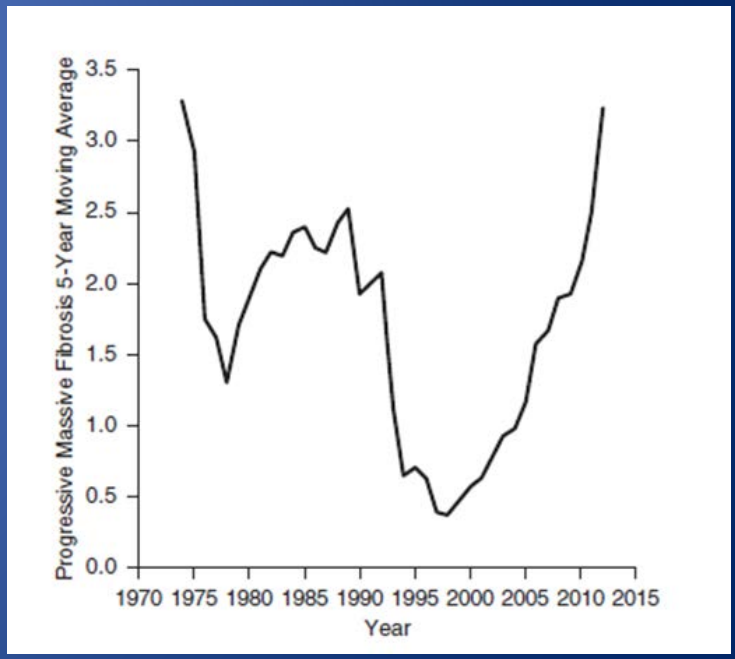
Coal Mining in the U.S.

- Mined in 25 states
- WY, WV, KY, IL, PA mine ~ 71% of the 1 billion short tons produced annually
- Provides 30% of electricity nationwide
- In March 2017, approximately 77,000 surface and subsurface coal miners

Health Effects of Respirable Coal Dust Exposure

- Chronic bronchitis
- Chronic Obstructive Pulmonary Disease (COPD)
- Coal Workers Pneumoconiosis (CWP)
- Progressive Massive Fibrosis (PMF)





MSHA 42 CFR Part 37 (August 1st, 2014)
Medical Examinations of Coal Miners

- Mine operators to provide each miner with periodic medical examinations inclusive of:
  - chest radiography
  - spirometry (lung function test)
  - respiratory symptom assessment
  - occupational coal dust exposure history
- No cost to coal miner
- Use medical facilities approved by NIOSH for testing
- Examination results to be provided by NIOSH to each miner and to the miner's designated physician

SPIROMETRY TESTING

NEWLY HIRED (Mandatory):

Coal miners first entering coal mining on or after August 1st, 2014

Current Coal Miners (Voluntary):

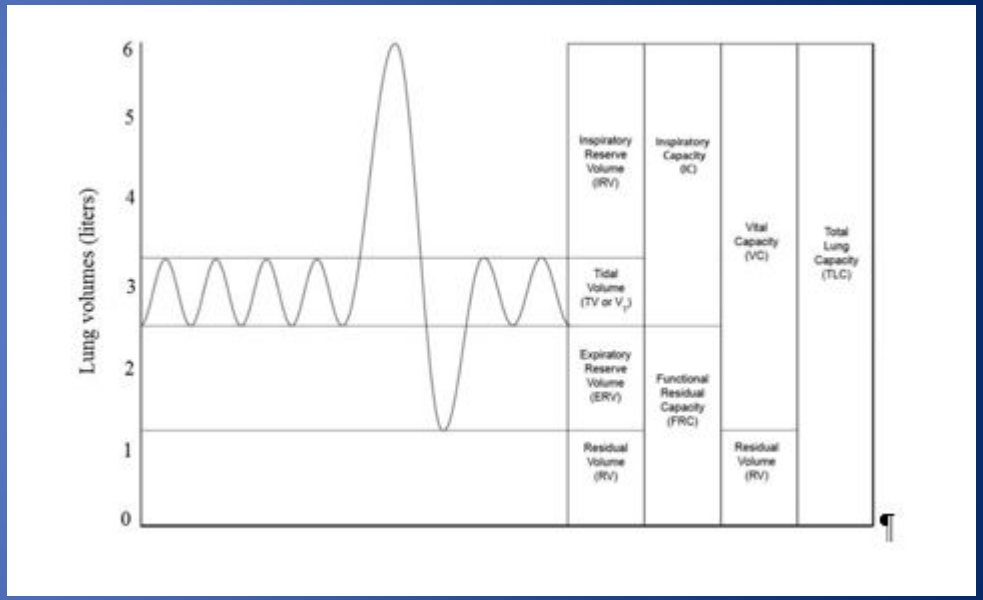
Active coal miners, first employed before August 1st, 2014

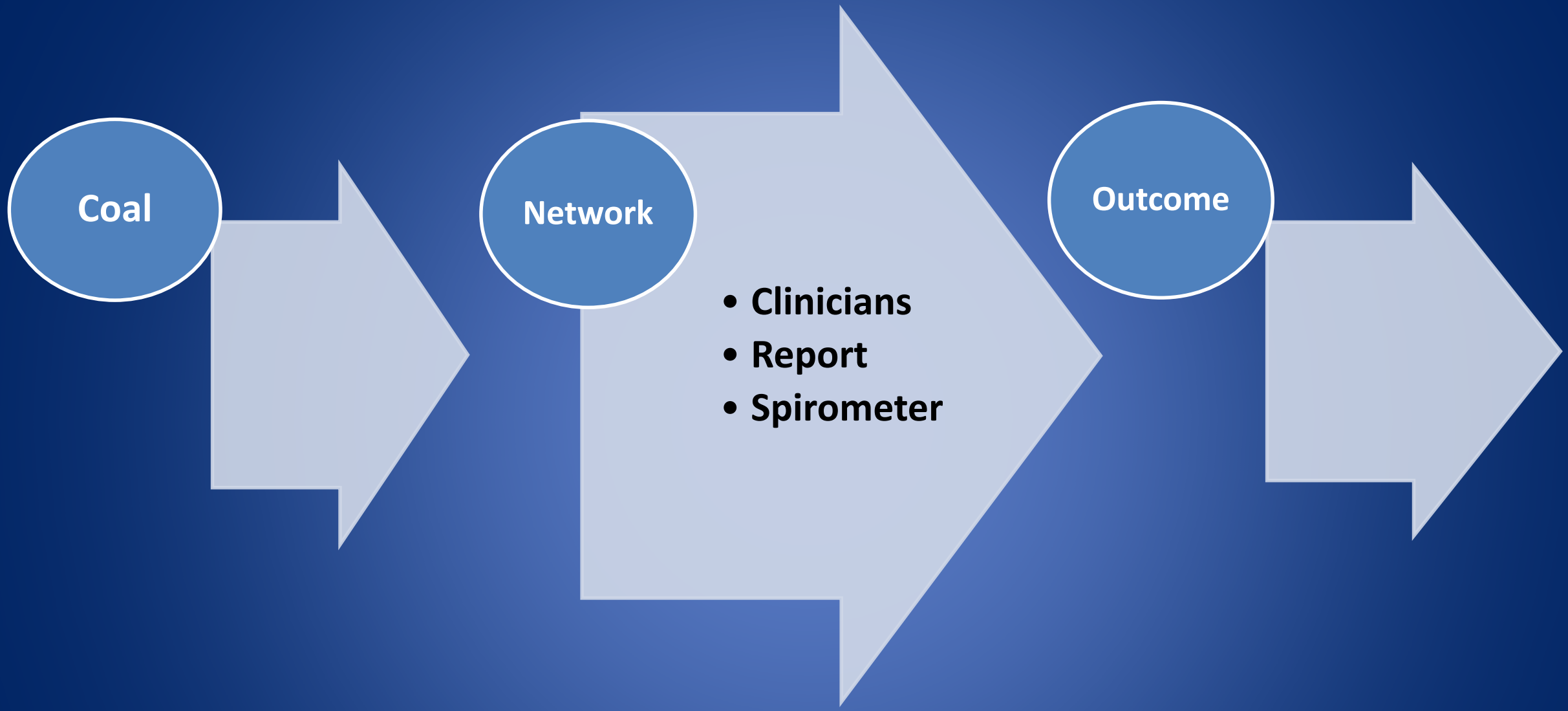
SERIAL SPIROMETRY:

Initial Spirometry, 2nd, and 3rd if evidence of abnormality

Spirometry

- Type of lung function testing performed for diagnostic purposes, worker health surveillance, public health surveys, or for disability screening
- Measures the volume of air that an individual can maximally and forcefully exhale from maximal inspiration
- Maneuver is called the forced vital capacity (FVC) and measures:
  - FVC
  - FEV1
  - FEV1/FVC (the ratio)




Coal
Network
• Clinicians
• Report
• Spirometer
Outcome

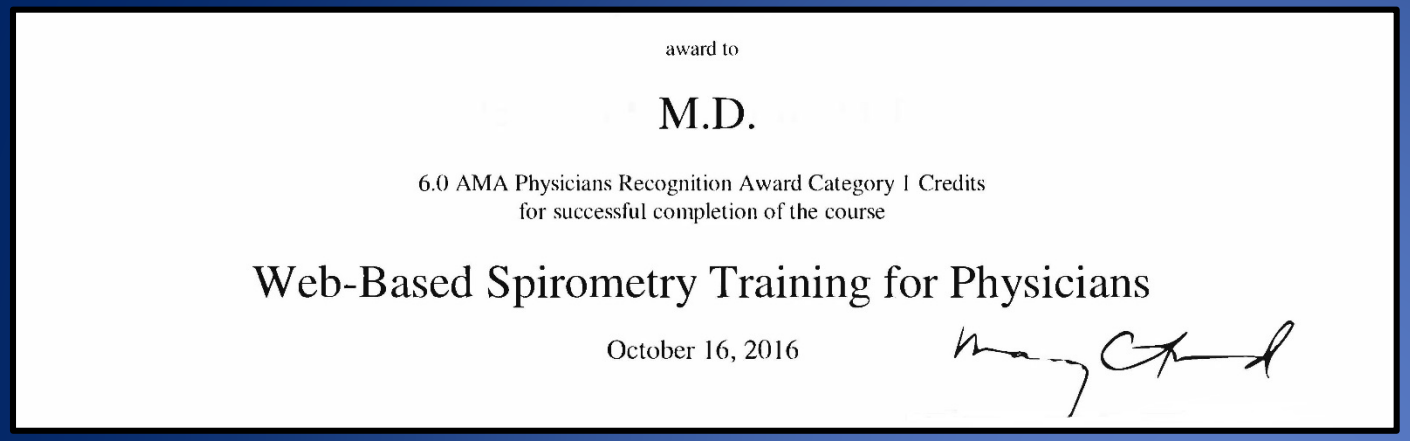
NIOSH SPIROMETRY NETWORK GOALS

1. Create a national network of NIOSH approved spirometry facilities
2. Develop secure electronic transfer of spirometry data for NIOSH review
3. Disseminate NIOSH interpreted spirometry reports to coal miners.
4. Provide information and guidance to spirometry facilities, individual practitioners, and spirometry technicians

SPIROMETRY FACILITY APPROVAL

- **PRACTITIONER**
  - Ensure that the supervising clinician and spirometry testing technicians display adequate knowledge to produce valid spirometry and standardized interpretation
- **SPIROMETRY REPORT**
  - Generate a standardized spirometry report to be distributed to CWHSP clinics
- **SPIROMETER/MANUFACTURER**
  - Identify spirometer models that adhere to specific spirometer specification guidelines

Practitioners and Spirometry Technicians



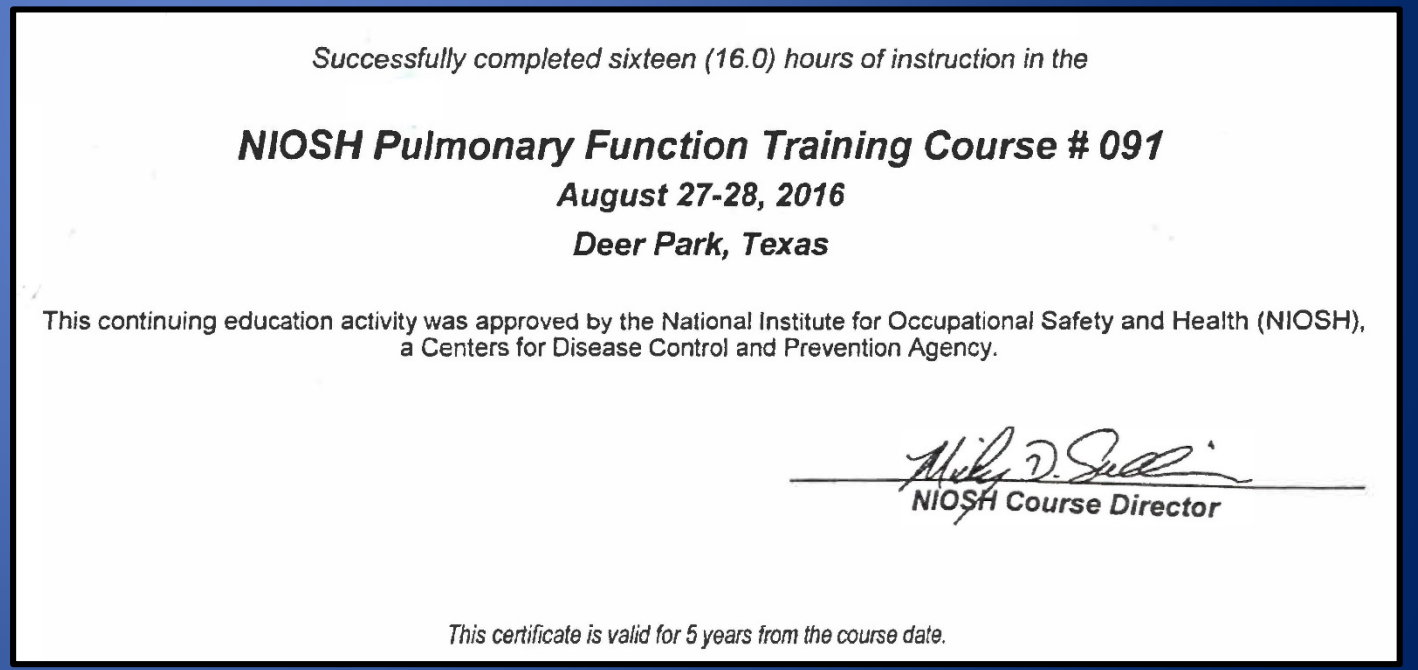
award to

M.D.

6.0 AMA Physicians Recognition Award Category 1 Credits
for successful completion of the course

Web-Based Spirometry Training for Physicians

October 16, 2016



Successfully completed sixteen (16.0) hours of instruction in the

NIOSH Pulmonary Function Training Course # 091

August 27-28, 2016

Deer Park, Texas

This continuing education activity was approved by the National Institute for Occupational Safety and Health (NIOSH), a Centers for Disease Control and Prevention Agency.

NIOSH Course Director

This certificate is valid for 5 years from the course date.

SPIROMETRY FACILITIES

- Clinic Information
- Practitioner Information
- Spirometer Identification
- Spirometry Technicians
- Identify Facility Deficiencies
- Ongoing Comments
- Generate and Track Spirometry Facility Approval & Updates

STANDARDIZED REPORT

NIOSH Sample Spirometry Report
CWHSP Clinic Name
4141 No Name Street
Utopia, WY XXXXX-XXXX
CWHSP Facility ID: XXXXX

Miner Name:
DOB
Age:
Sex
Height (in):
Weight (lbs):
Race:
Smoker:
Comments:

Test Date: XX/XX/XXXX xx:xxxx
Calibration Date/Time: XX/XX/XXXX xx:xxxx
Spirometry Model: Serial#:
Barometric (mmHg): BTPS:
Ambient Temp (C°): RH (%) :
Predictive Ref: NHANESIII
Testing Technician:
Testing Position:

Parameter	Pred	LLN	Best	%Pred	Trial1	Trial2	Trial3
FVC (L)	X.XX	X.XX	X.XX	XX.X	X.XX	X.XX	X.XX
FEV1 (L)	X.XX	X.XX	X.XX	XX.X	X.XX	X.XX	X.XX
FEV1/FVC (%)	X.XX	X.XX	X.XX	XX.X	X.XX	X.XX	X.XX
$FEF_{25\%-75\%}$ (L)	X.XX	X.XX	X.XX	XX.X	X.XX	X.XX	X.XX
FEV6 (L)	X.XX	X.XX	X.XX	XX.X	X.XX	X.XX	X.XX
FEV1/FEV6 (%)	X.XX	X.XX	X.XX	XX.X	X.XX	X.XX	X.XX
PEF (L/sec)	X.XX	X.XX	X.XX	XX.X	X.XX	X.XX	X.XX
FET (sec)					X.XX	X.XX	X.XX
Vext (L)					X.XX	X.XX	X.XX

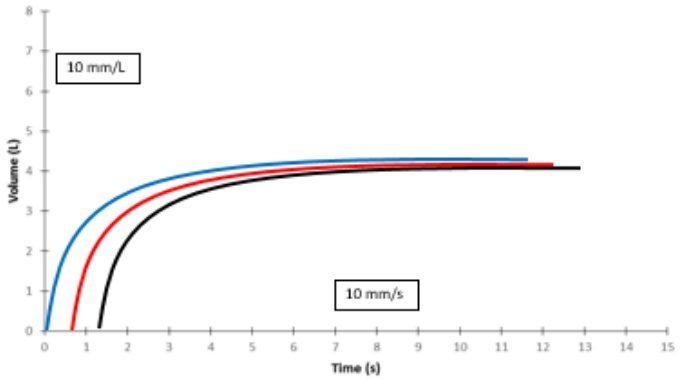
* Trial used for Best; Acceptability (FEV1 var= x.xxL (X.X %); FVC var=x.xxL (X.X%)

Physician Interpretation

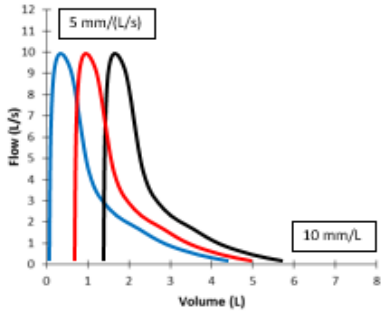
Signature _____ Date XX/XX/XXXX

Option 1: Curves are staggered at ATS size standards, no need for individual graphs

FVC Volume-Time Graphical Output (Staggered)



FVC Flow-Volume Graphical Output (Staggered)



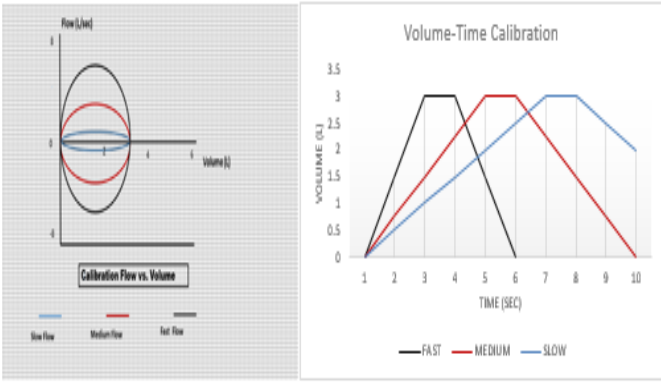
June 23, 2016

Three Liter Syringe Calibration:

Calibration Date: XX/XX/XXXX Time: XX:XX Ambient Temperature (C°):XX Barometric Pressure (mmHg): XXX
Serial Number:
Calibrated by:

	Syringe Volume (L)	Injection1	Injection 2	Injection 3
		Measured	Measured	Measured
FVC (L)	3.00	X.XX	X.XX	X.XX
PEF (L/S)		XX.XX	XX.XX	XX.XX

Examples of Flow vs. Volume and Volume vs. Time Calibration Printouts:



June 23, 2016

SPIROMETER SPECIFICATIONS

National Institute for Occupational Safety and Health (NIOSH)

Coal Workers' Health Surveillance Program (CWHSP)

Spirometer Manufacturer & Model Information for Clinics

1. Graphical displays must provide real-time volume-time and flow-volume curves during the test. These displays must meet or exceed a minimum size.

2. The spirometer software must automatically perform quality assurance checks on expiratory maneuvers during each spirometry testing session.

3. Each spirometer must contain enough active memory to store absolute values from at least 8 maneuvers within one testing session.

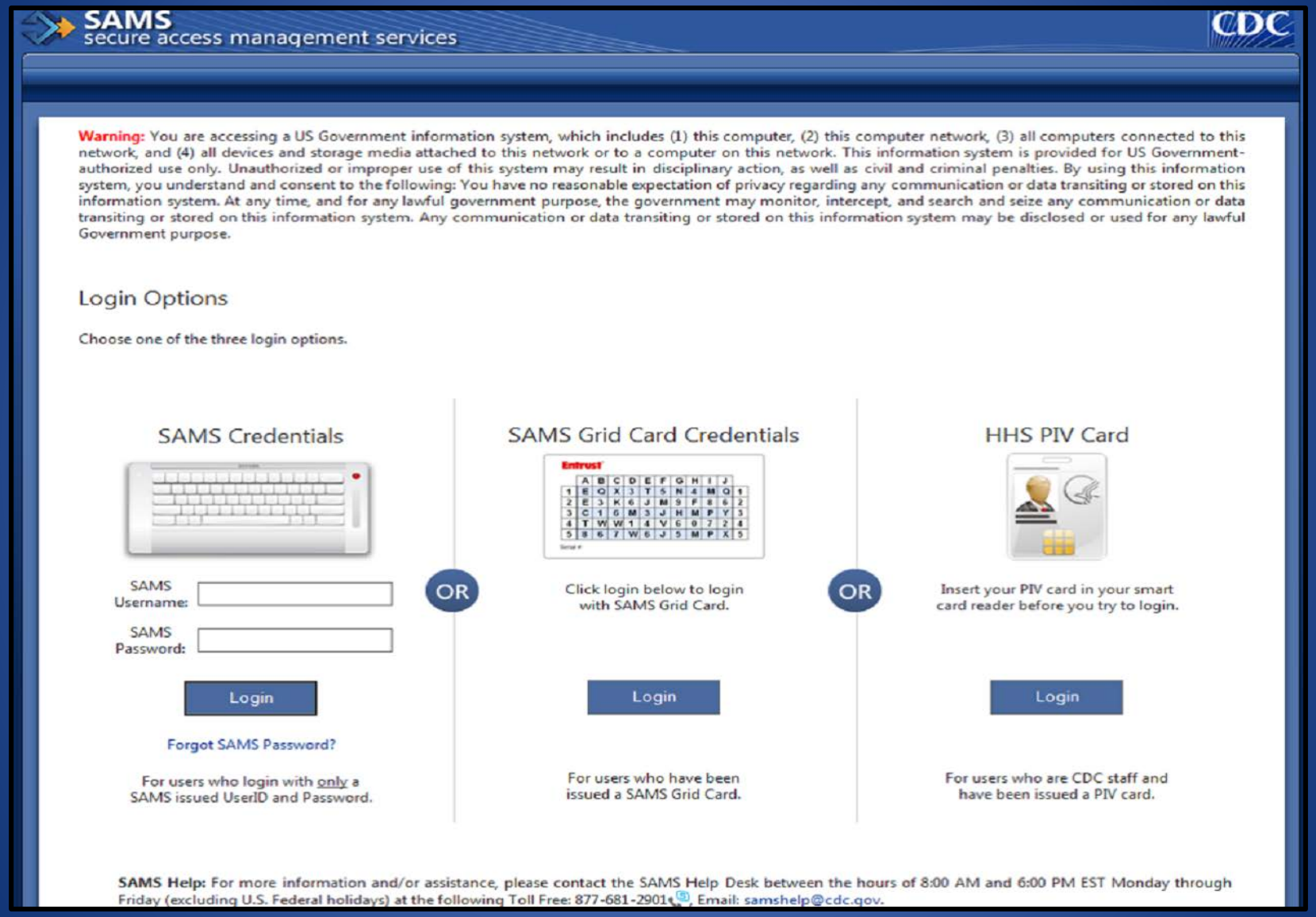
4. Spirometers must provide electronic transfer of spirometry data points.

NIOSH CWHSP Spirometer Table

Manufacturer	Model	*Actively working with NIOSH CWHSP	CWHSP PDF Report printout (good until Feb. 2018)	Manufacturer actively developing Electronic Data Transfer for this Model	Electronic Data Transfer Capable (good after Feb. 2018)
Benson	CS-200	*	*	*	
Carefusion	Vintus	*	*	*	
MedGraphics	Platinum Elite	*	*		
Ndd Medical	EasyOn _ PC	*	*	*	*
Vitalograph	Pneumotrac	*	*	*	
Cohero Health		*	*	*	
MIR		*	*		
Welch Allyn	Spiroperfect	*	*		

Any specific product named does not reflect any endorsement or collaboration by the National Institute of Occupational Safety and Health

SECURE DATA DOWNLOAD



COAL MINER SPIROMETRY REPORTS

Report of Spirometry Results

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
1095 Willowdale Road
Morgantown, West Virginia 26505

Name:
Study: CWHSP

02742111

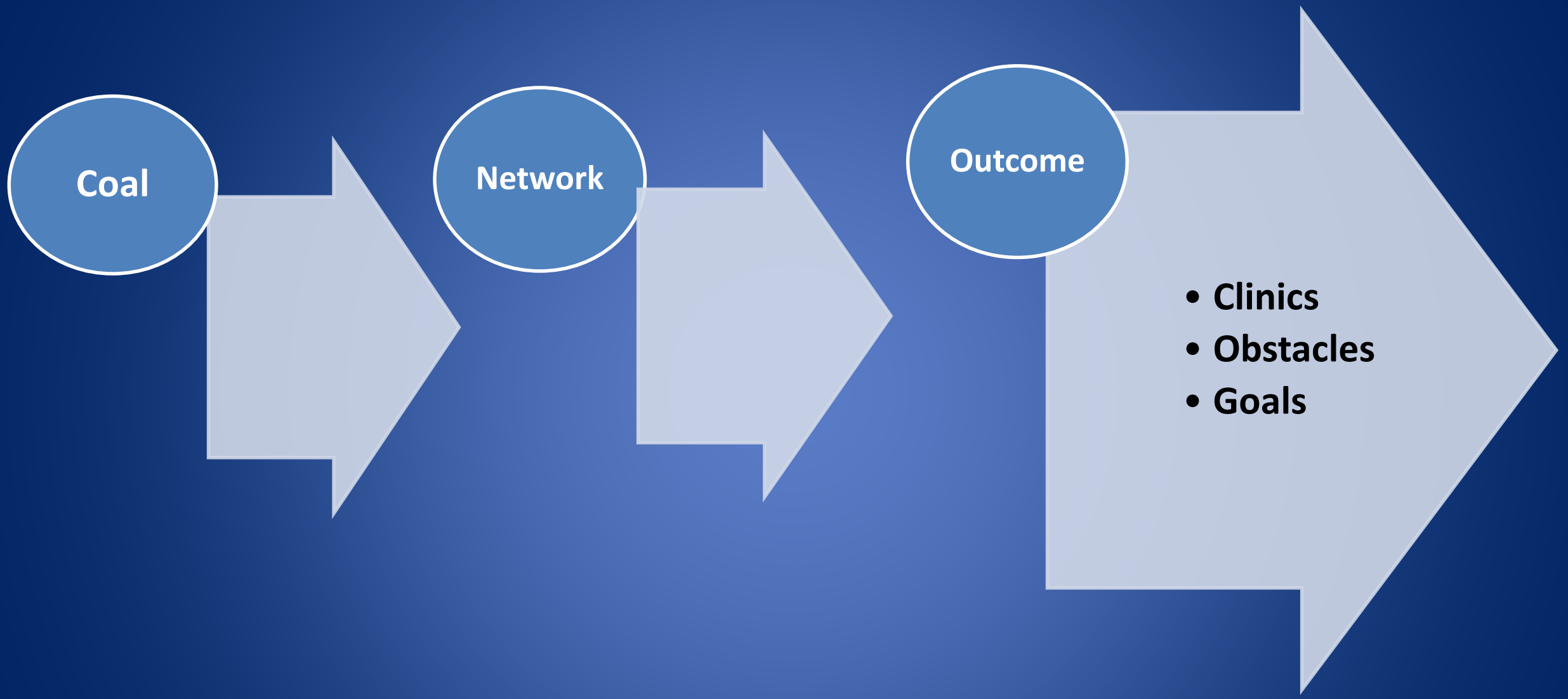
ID: 274211
Age: 60
Height: 168.0 cm
Weight: 100 kg
Body Mass Index: 35.4 kg/m2
Gender: Male
Race/Ethnicity[2]: C

Test Date/Time: 9/9/2016
Calibration Check Date: 9/9/2016
Spirometer Serial Number: 226731

Technician: 046

	Trial	FVC	FEV1	FEV1/FVC%	PkFlow	FEV6
	3	3.46	3.06	88.4 %	10.32	3.44
	1	3.44	2.97	86.3 %	10.90	3.42
	2	3.28	2.91	88.7 %	10.55	3.27
Best Values		3.46	3.06	88.4 %	10.90	3.44
Predicted Values[3]		4.14	3.13	76.0 %	8.38	3.94
LLN[3,4]		3.31	2.43	66.0 %	6.31	3.13
Percent Predicted		83.6 %	97.7 %	116.4 %	130.1 %	87.4 %

Interpretation:
Normal expiratory flows and a normal FVC.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SPIROMETRY FACILITY APPROVALS

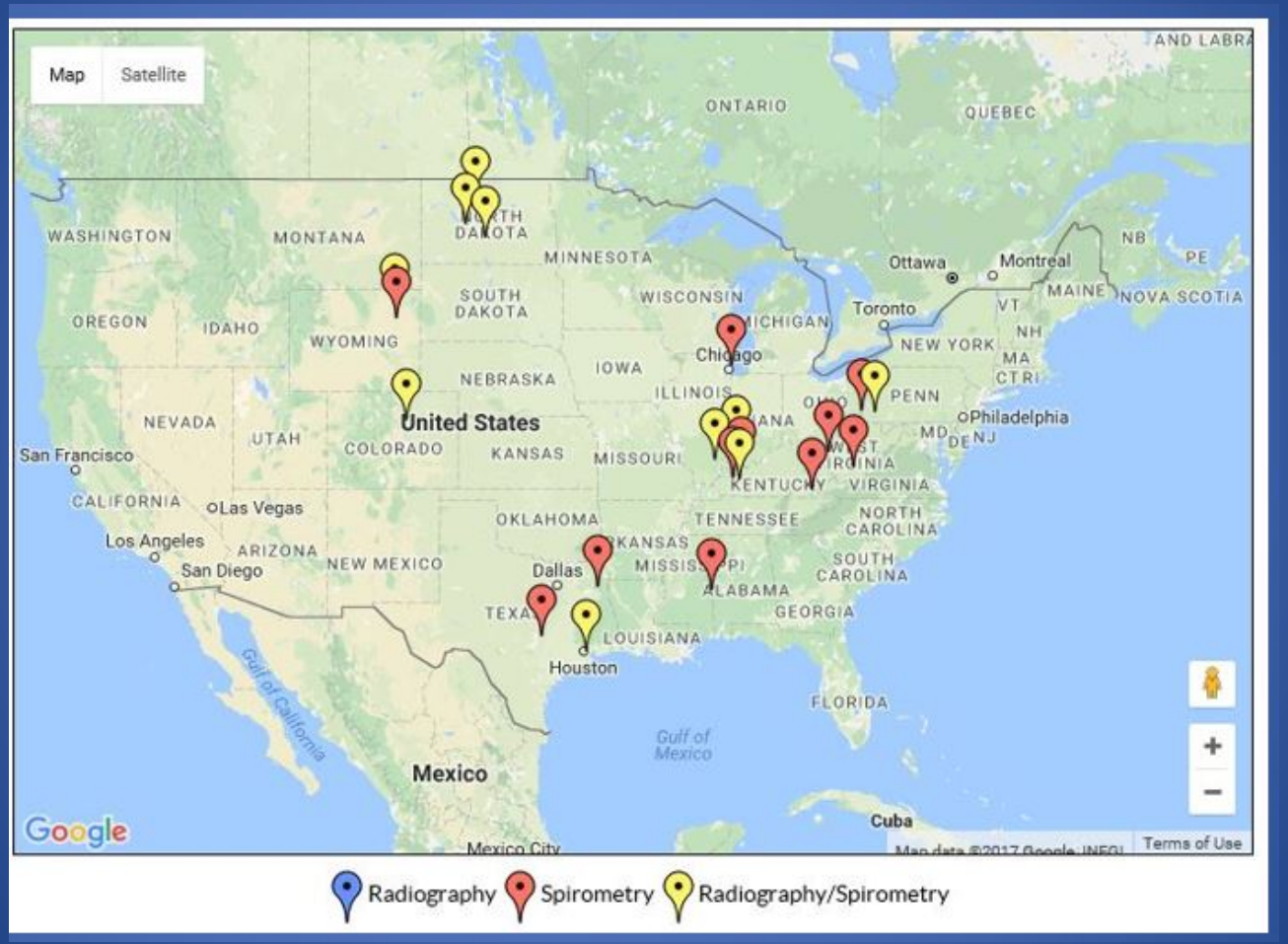
- MSHA to require mine operators to include spirometry facilities in their mine plans (staggered roll-out, not yet required)

- First clinic approvals on August 5th, 2016:
  - 13 spirometry facility approvals in seven states
  - Wyoming, West Virginia, Texas, North Dakota, Kentucky, Illinois and Indiana

- Currently, 23 clinics in 11 states:
  - Colorado, Ohio, Mississippi, and Pennsylvania

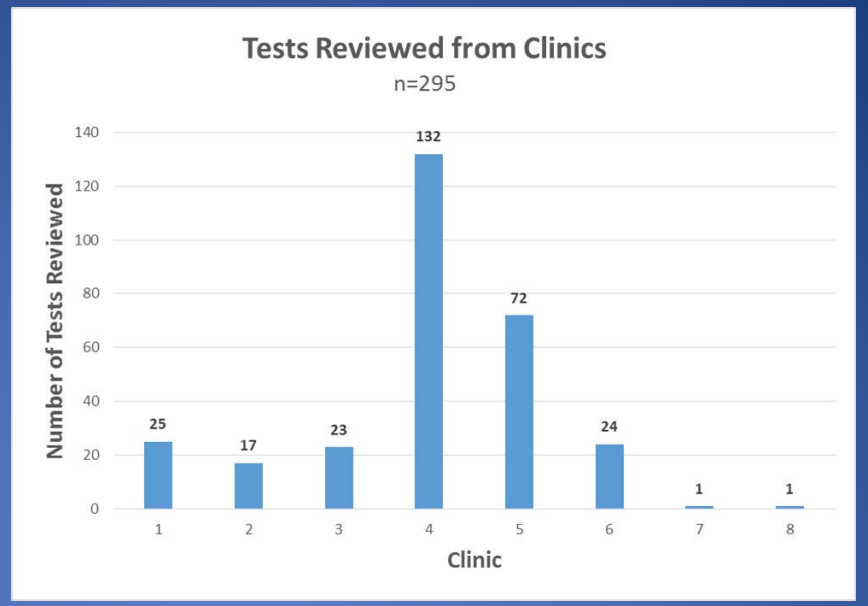
- Additional 18 clinics have applied; with 8 facilities under active review

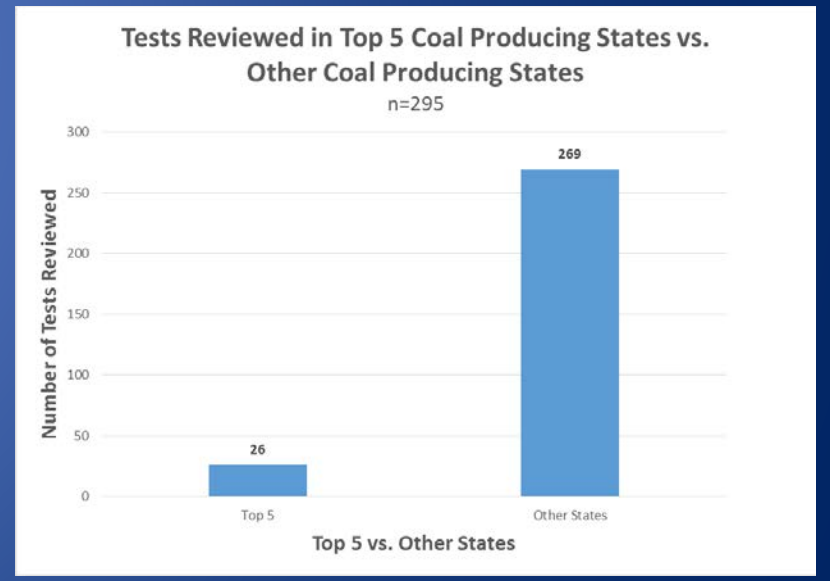
CWHSP APPROVED SPIROMETRY FACILITIES



SPIROMETRY REPORTS RECEIVED

- MSHA has not yet launched; but already receiving reports from approved clinics
- 429 miner spirometry reports received
- 295 reports processed and results sent to miners
- Receiving spirometry from 8 of the 23 approved clinics
  - Most from mobile units in Texas
- Disproportionate state distribution
  - Top 5 vs. Others





RESULTS: UNFORESEEN OBSTACLES

- Clinicians without NIOSH spirometry training
- Cost prohibitive
- Attrition of staff or primary care provider
- Clinics not properly downloading their test reports to NIOSH
- Spirometer manufacturers taking longer to provide electronic report downloads

FUTURE GOALS

- Expand geographical coverage and number of spirometry facilities, especially in the high coal producing regions
- Provide facility guidance and feedback
- Help advance the development of ‘next generation’ spirometer models
- Investigate coal miner longitudinal lung function
- Monitor spirometry test acceptability and repeatability

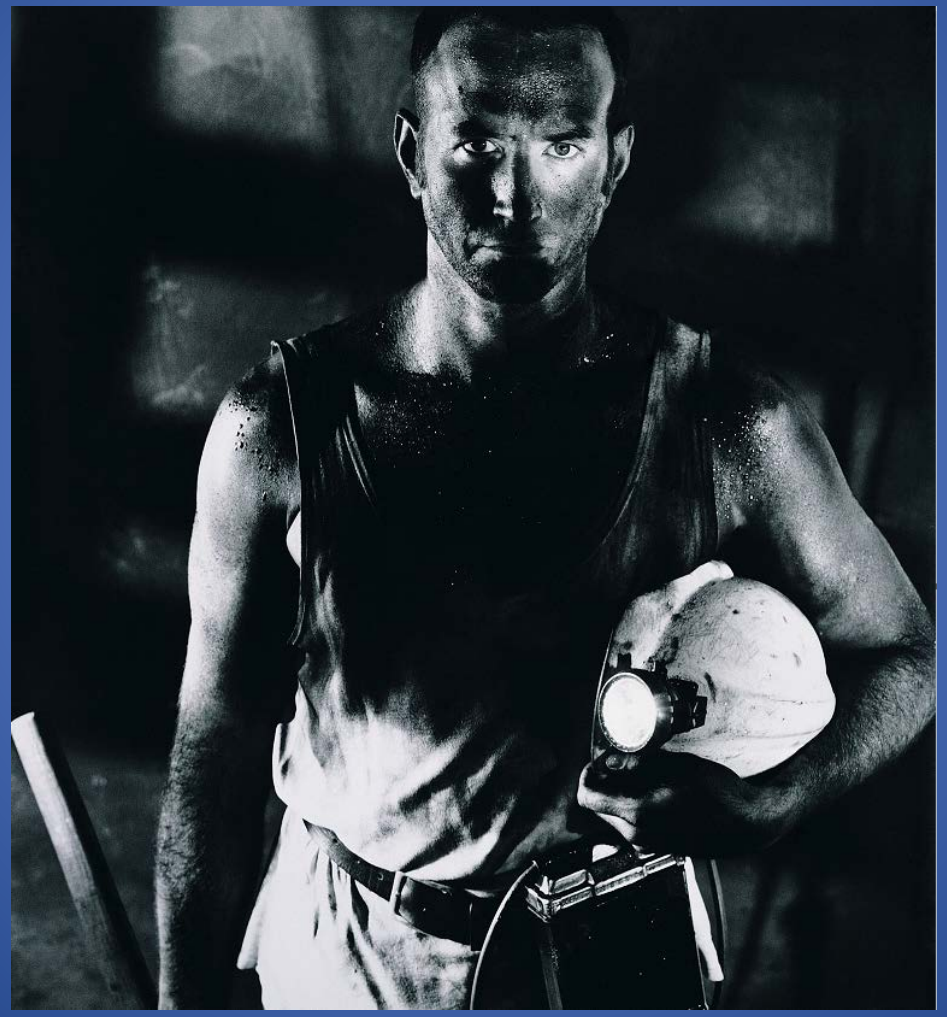
References

- Attfield MD and K Morring. 1992. An investigation into therelationship between coal workers' pneumoconiosis and dust exposure in U. S. coal miners. Am Ind Hyg Assoc J 53(8):486-492.

- Laney AS and DN Weissman. 2014. Respiratory diseases caused by coal mine dust. J Occup Environ Med. 56 Suppl 10: 18-22.

- Blackley DJ, CN Halldin, AS Laney. 2014. Resurgence of a debilitating and entirely preventable respiratory disease among working coal miners. Am J Respir Crit Care Med 190(6): 708-709.,

Thank You and Any Questions?



Dairy Worker Exposure to Airborne Endotoxins and β-Glucans

Amanda VanDyke

Advisor: Stephen Reynolds

Co-Authors: Joshua Schaeffer, Sheryl Magzamen

This project was made possible by the *High Plains Intermountain Center for Agricultural Health and Safety (HICAHS)* and *NIOSH Grant OH010840-03*

HIGH PLAINS INTERMOUNTAIN CENTER
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Colorado State University

National Institute for Occupational Safety and Health
NIOSH

Overview

- Background on Dairy Industry
- Sample Collection Methods
- Data Analysis
- Results
- Conclusions
- Limitations

Dairy Industry

- Unique Sector in Agriculture
- Increases the risk for occupational injury and illness
- Approximately 60,000 dairy farms in the U.S.
  - 21 billion gallons of milk every year

Photo credit: Farm Policy News

Dairy Industry

- Number of large-herd operations is increasing (>500 head)
- Between 1990-2012 total herd number decreased from 195,000 to 58,000
  - Total amount of milk produced has continued to increase (147,000 to 206,000 pounds)
- Has a higher incidence rate of non-fatal injuries
  - 6.2 per 100 full-time workers

Photo credit: New Mexico State University

Dairy Workforce

- Change in dairy industry changes the demand for the workforce
  - A dairy farm needs approximately 1 dairy worker for every 80-100 cows
- Immigrant workers have met the demand for this increase

Photo credit: Milwaukee-Wisconsin Journal

Immigrant Workforce

- 70% of the dairy workforce are immigrants
  - Majority are Latino workers
- No prior agricultural work experience
- Workers without previous experience have a unique susceptibility to respiratory disease

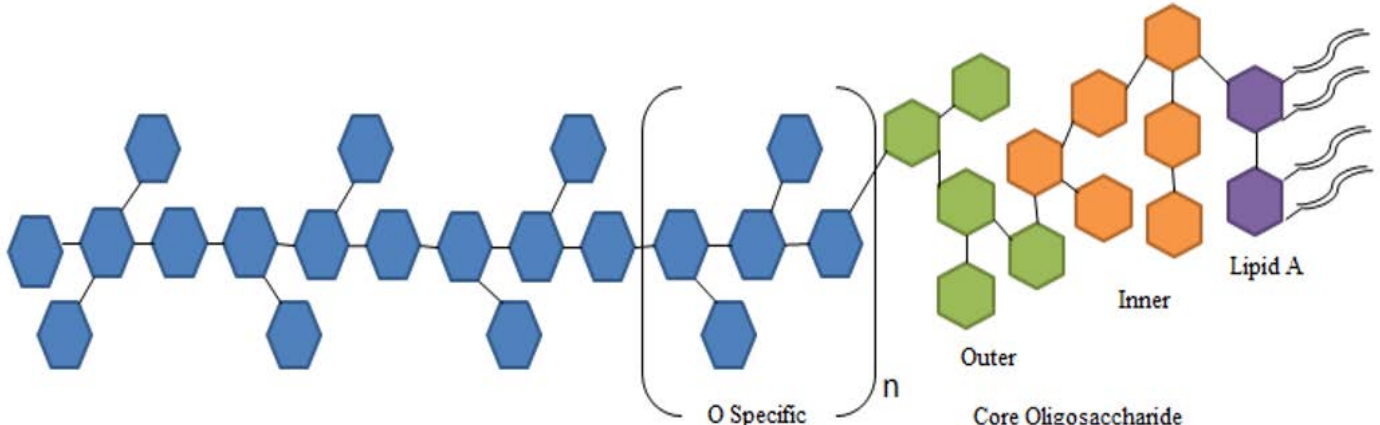
Photo credit: Addison Independent

Respiratory Health

- Relationship between reduced respiratory function and concentration/length of exposure to air contaminants
- Cross-shift lung function decline
- Increased rates of obstructive respiratory diseases

Endotoxins

- Gram-negative bacteria
- Outer membrane of cell wall
- Pro-inflammatory reaction
- Linked to respiratory disease
  - Chronic bronchitis, reduce lung function, nose and throat irritation, organic dust toxicity syndrome, asthma



Endotoxins

- After cell death, endotoxins can be released in large quantities
- Gram-negative bacteria are ubiquitous
- Studies date back to 1987 linking respiratory disease and endotoxin exposure
- No occupational standard for endotoxins
  - Dutch have proposed 90 EU/m^3
- Healthy worker effect

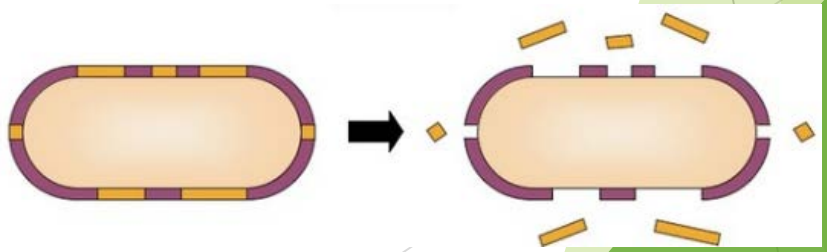


Photo credit: Wear Your Genes

Fungal Exposure

- Fungi identified as causative agents of respiratory disease
- Three general mechanisms of fungi health impacts:
  - Harmful immune response
  - Direct infection
  - Toxic irritants

Photo credit: Diflucan Home

Fungal Exposures

- Common respiratory diseases:
  - Hypersensitivity pneumonitis
  - COPD
  - Asthma
  - Reduced pulmonary function
- Active mold spores and mycotoxins are not the only culprit
- Fungal constituents also play an important role

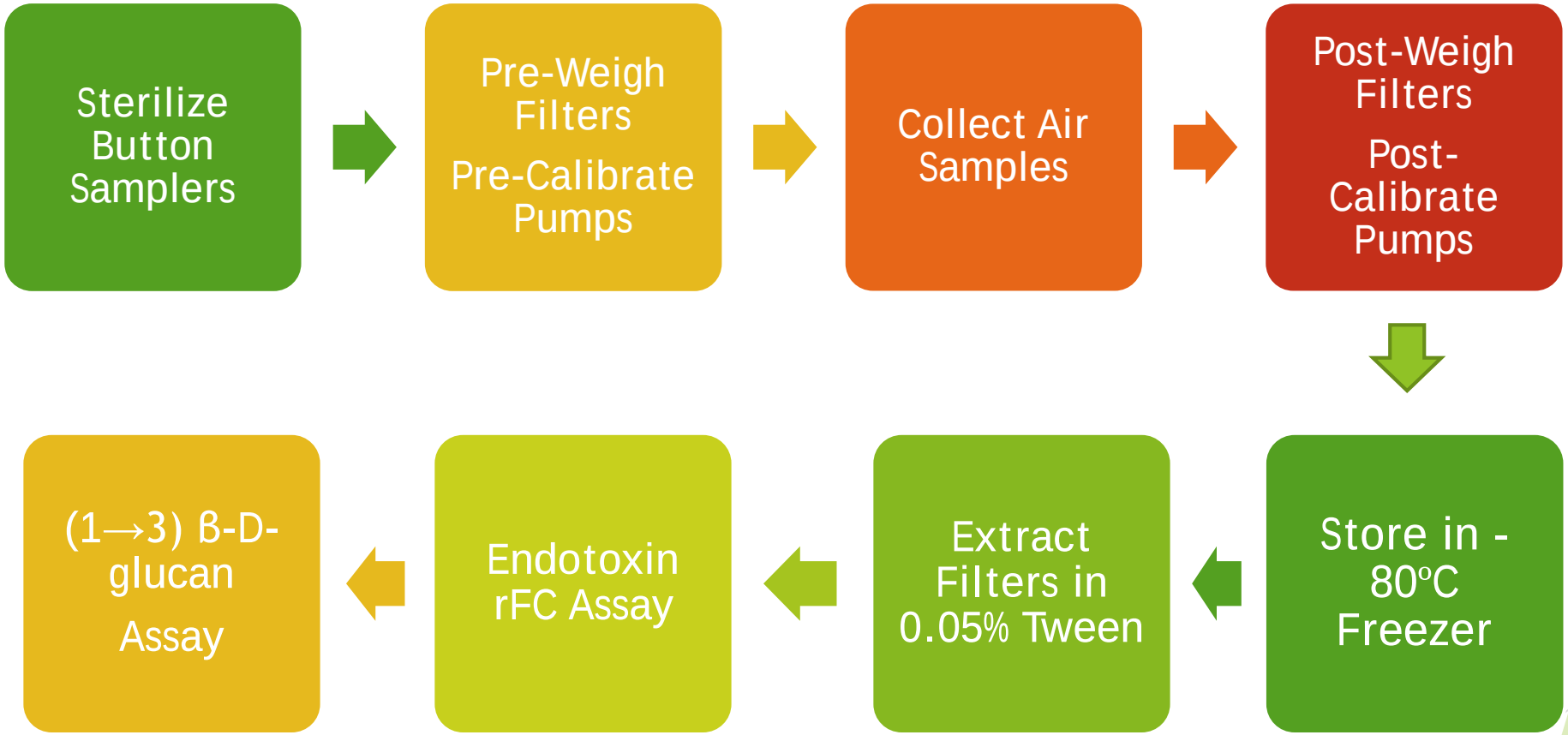
Study Aim

- **Characterize worker exposure to two bioaerosols constituents based on task among dairy workers across four dairies and two seasons.**

Sample Collection

- Samples were collected at 4 large herd dairies (>1000 lactating cows) in northern Colorado
- Personal and area air samples were collected over nine weeks from March-September 2015
- SKC button sampler was used for all air samples with a polyvinyl chloride filter at a flowrate of 4 L/min

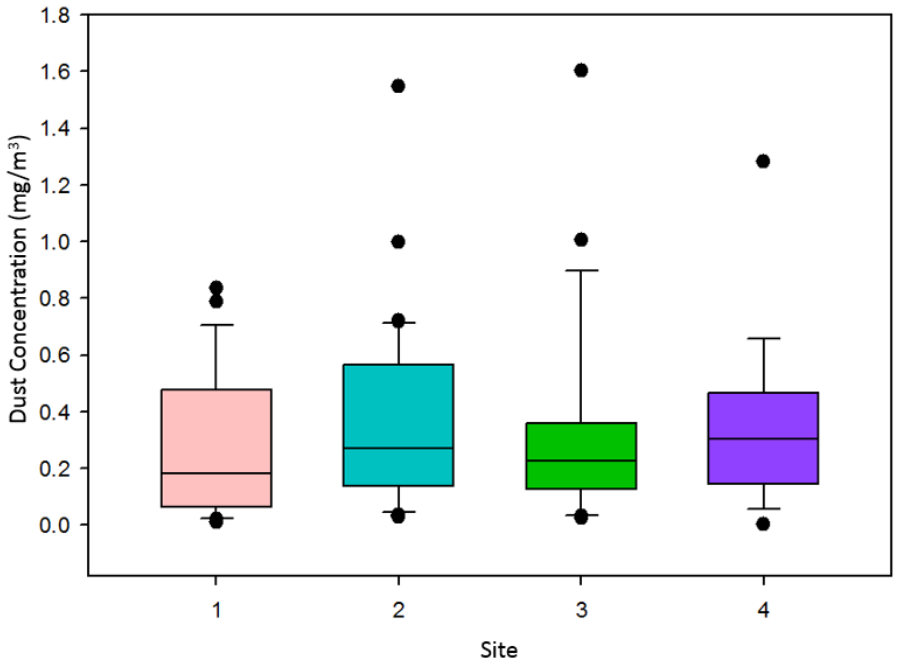
Sample Collection

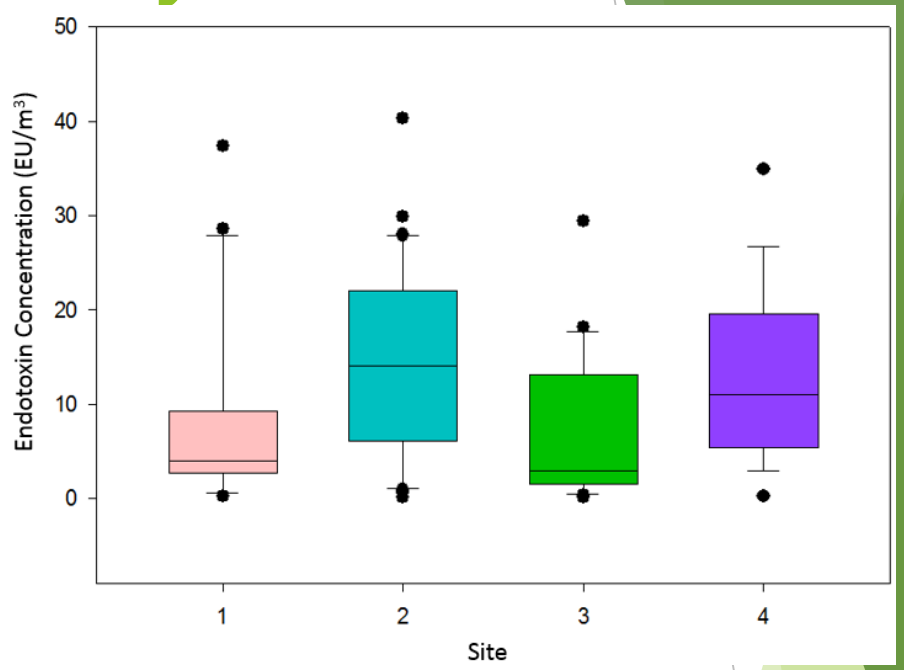


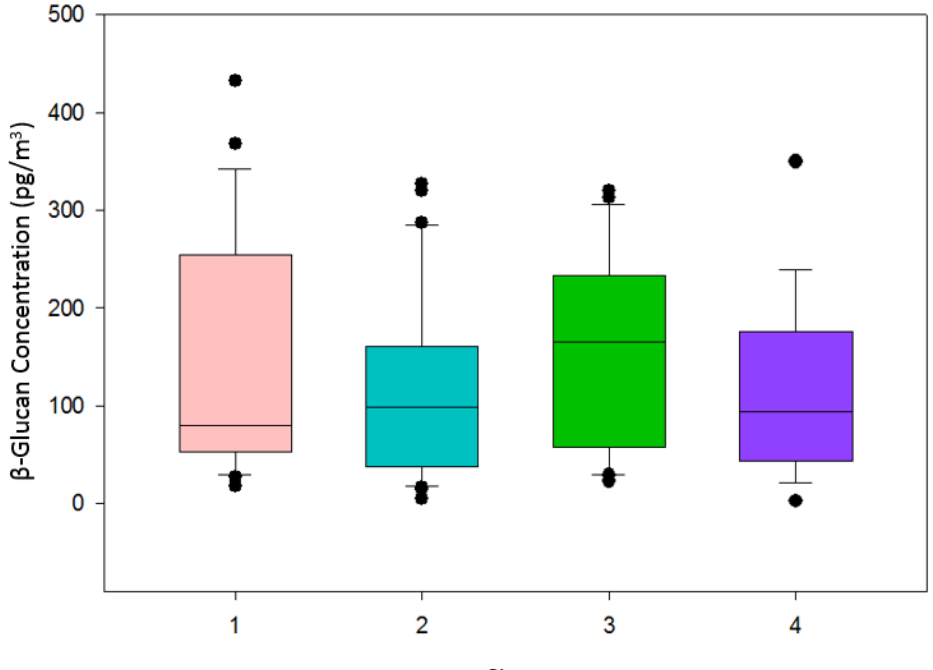
Sample Summary

- 436 Air Samples
  - 139 Personal Samples
    - 38 Different Workers
      - Birthing
      - Irrigation
      - Machine Operator
      - Medical
      - Milking
      - Mixing Feed
      - Multi-Task
      - Rebedding
  - 297 Area Samples
    - Downwind
    - Parlor
    - Upwind

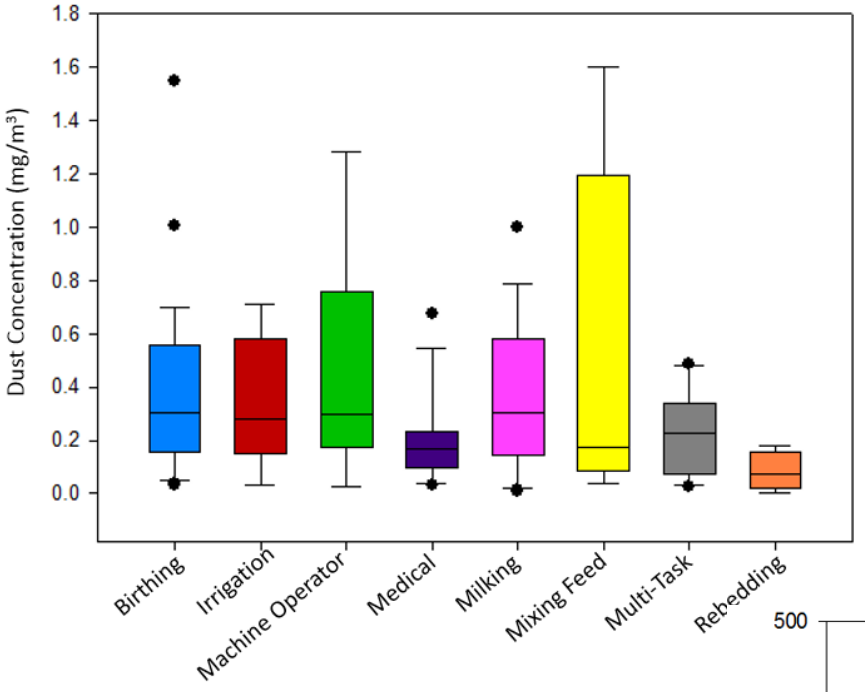
Personal Concentration by Site

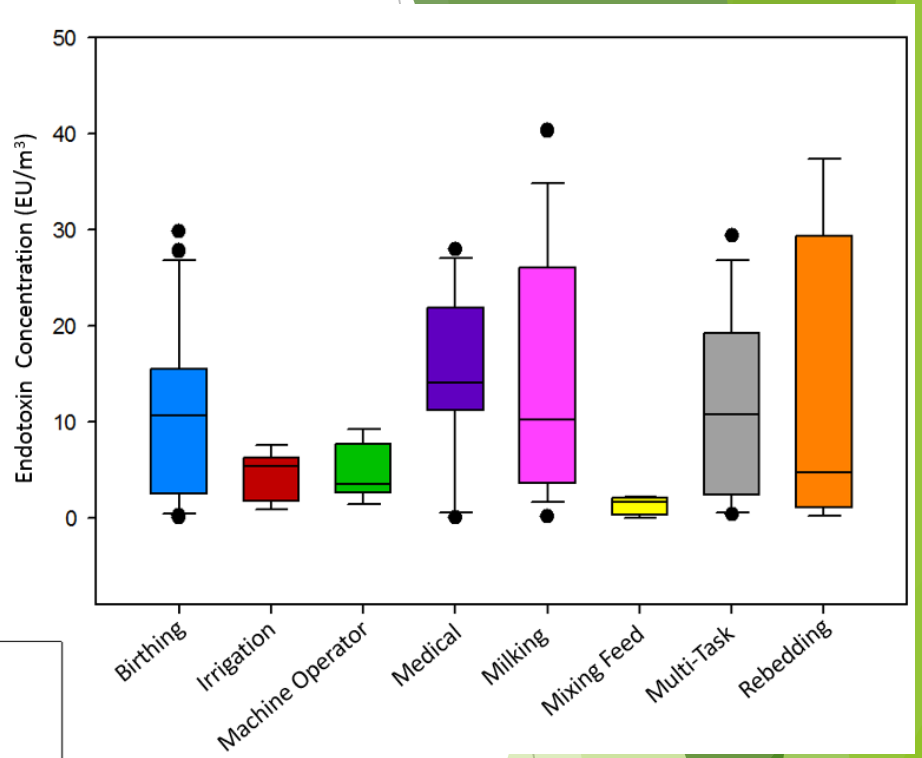


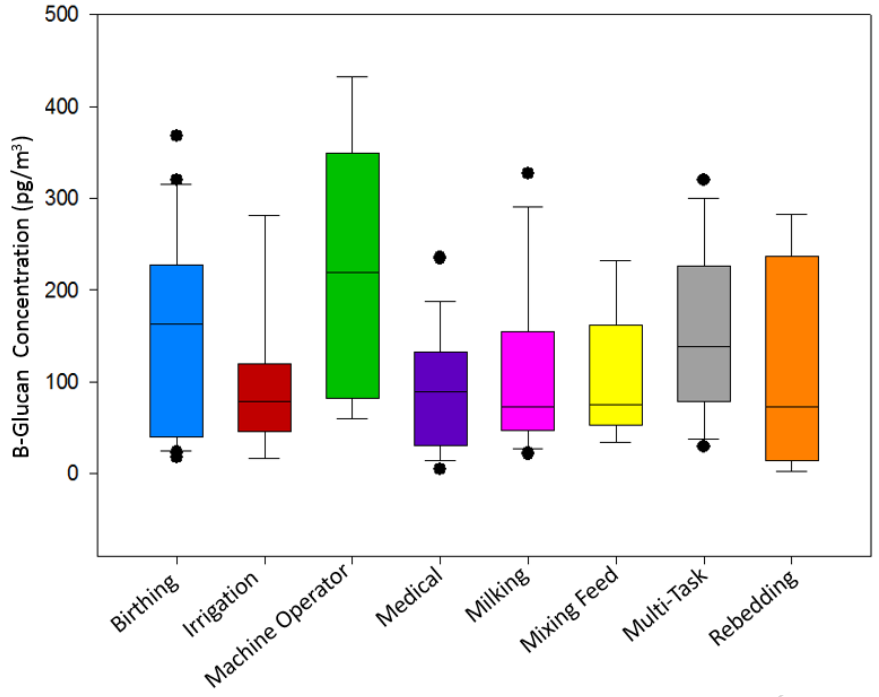




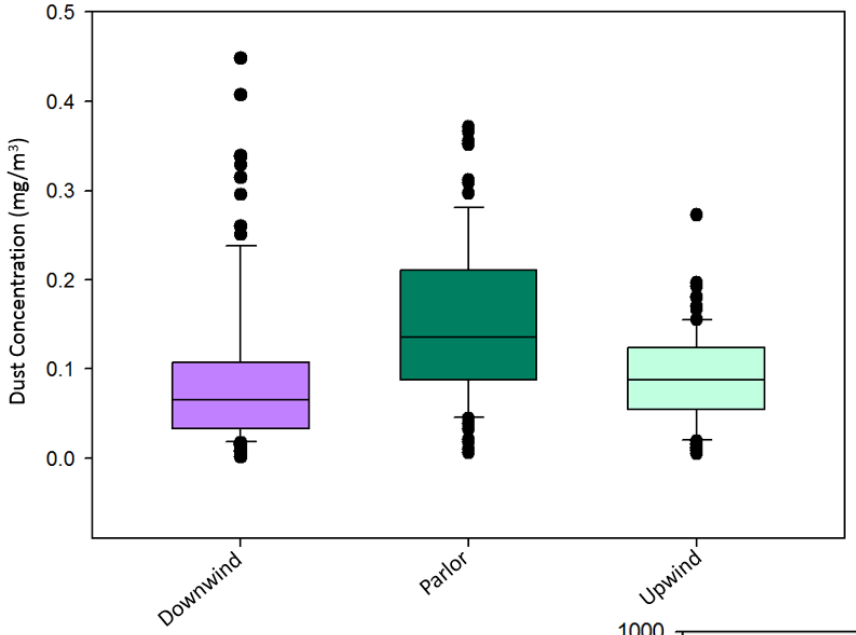
Personal Concentration by Task

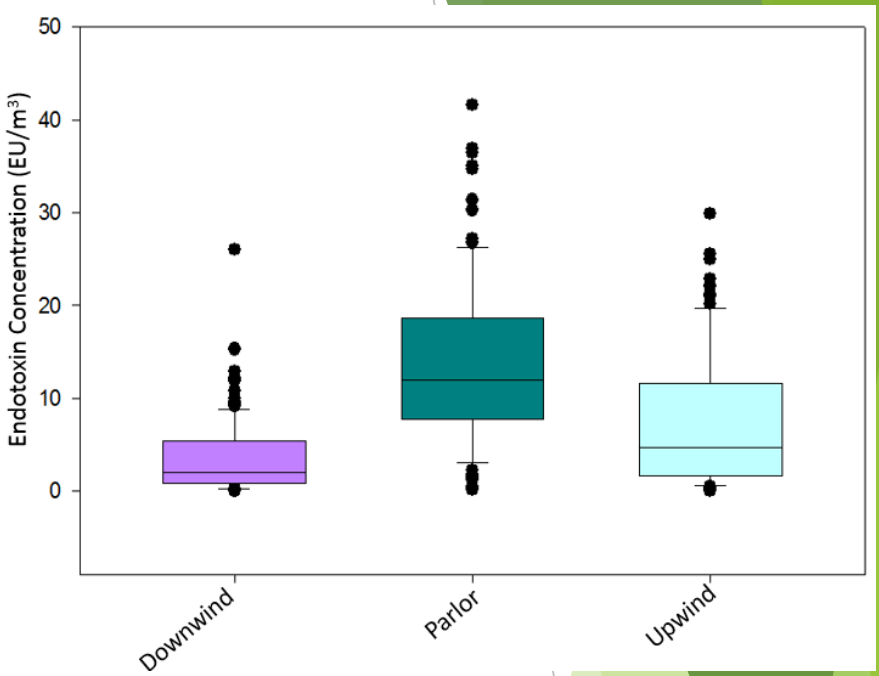


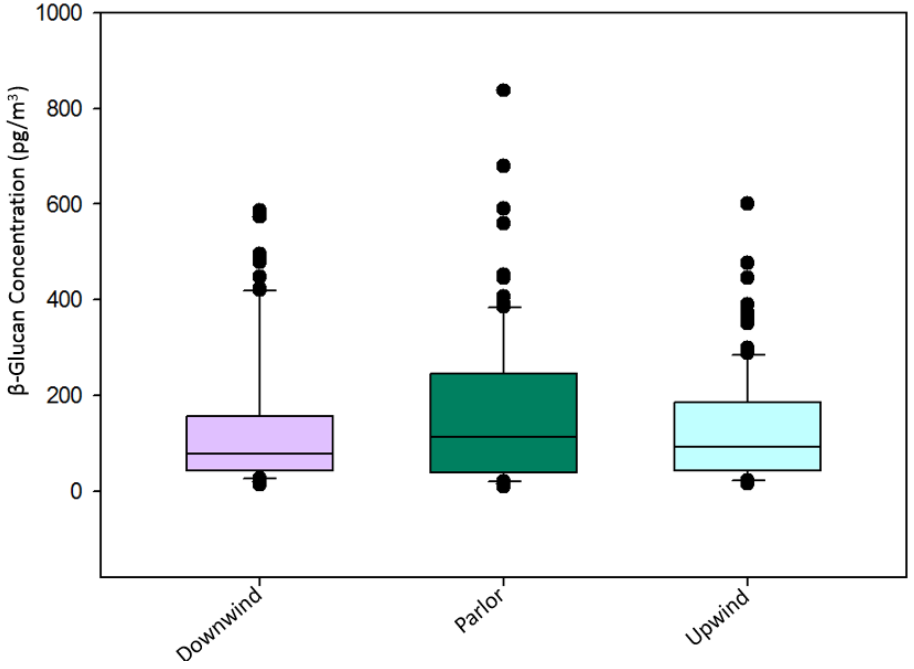




Area Dust Concentration by Location







Conclusions

- Differences in site were not statistically significant
- Mixing feed had the highest dust concentration
- A lot of variability between tasks
- Parlor had the highest concentration for area samples

Limitations

- Some tasks had small sample sizes
  - Limited by number of volunteers
- Did not capture all tasks at the dairy
- Small sample size for some of the sites

Future Work

- Further investigation into interventions to reduce worker exposure
- Compare exposure concentration to worker health response data

Acknowledgements

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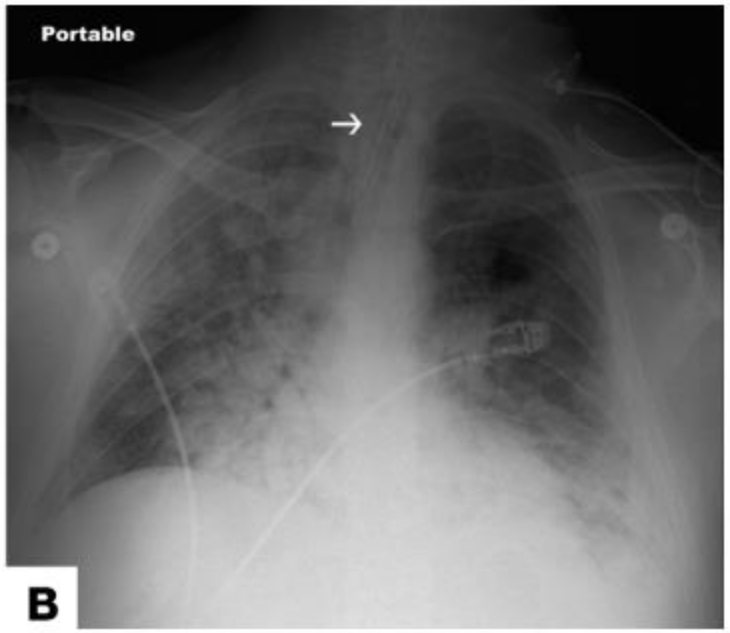
Questions

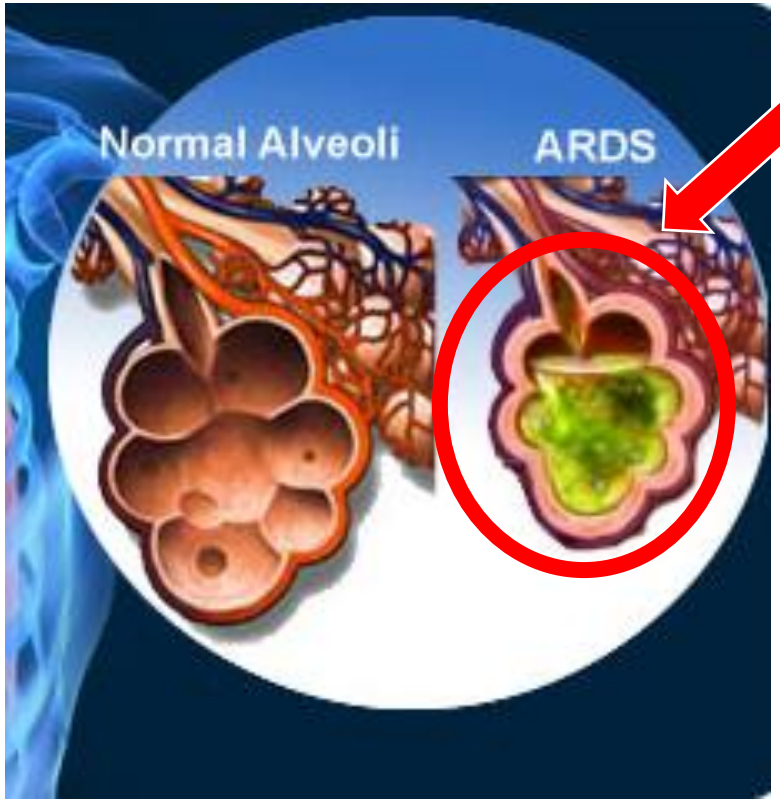
HARVARD T.H. CHAN
SCHOOL OF PUBLIC HEALTH

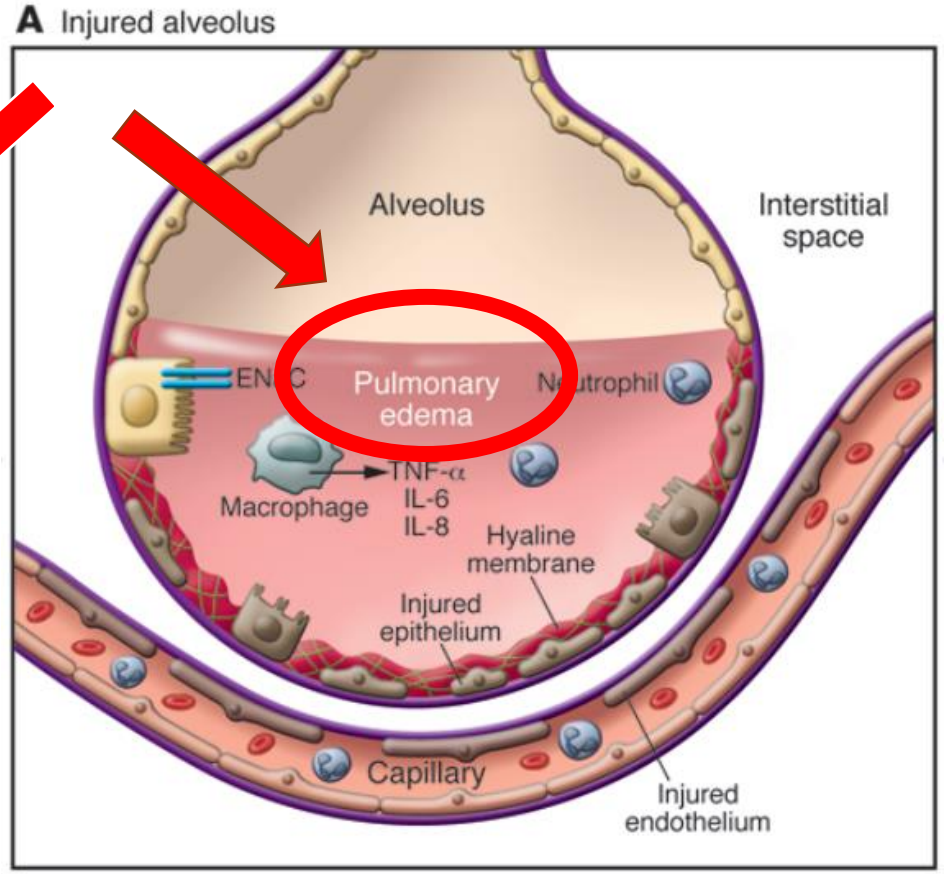
INDUSTRIES AND ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS) RISK

Harvard T.H. Chan School of Public Health
Department of Environmental Health
Jongeun Rhee

ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS)







Reference:
https://www.jci.org/articles/view/60331/version/1/pdf/render

ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS)

- The most severe form of acute respiratory failure
- ARDS represented 10.4% of total ICU admissions and 23.4% of all patients requiring mechanical ventilation [Bellani, 2016]
- ARDS ICU mortality rate ranging from 30% to 75%
- The incidence of ARDS: 64.2 to 78.9 cases/100,000 population-year in U.S [Frutos-Vivar, 2004]

RISK FACTORS OF DEVELOPING ARDS

Clinical:

Sepsis

Severe trauma

Pneumonia

Environmental:

Smoke inhalation

Air pollution: Ozone

Cigarette smoke

Occupational:

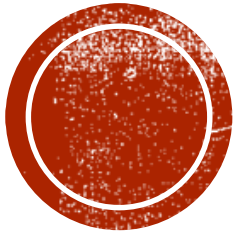
Toxic chemicals inhalation/ingestion

(20 case-reports)

STUDY AIM

- To investigate the impact of industries (construction and manufacturing) on acute respiratory distress syndrome (ARDS) risk for nearby residents, including workers as well as community residents

- *Hypothesis : residents living in area with denser aggregation of industries are more likely to be exposure to inhaled toxicants, which are associated with increased risk of lung injury*



DATA & DATA CHARACTERISTICS

- **Study population**:

1) Medicare enrollees (≥ 65 years old) across the United States.
2) Obtained hospital discharge records for ARDS using *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM)

- **Industry data**:

1) Arc GIS Business Analyst data
2) Classified companies by SIC codes: construction (15-17), manufacturing (20-39)

- **Air pollution data**:

Spatiotemporally resolved predictions using satellite AOD data, monitoring data, and LUR variables

MEDICARE ENROLLEES (2006-2012): YEARLY AVG. 29.1 MILLIONS

Individual-level summary characteristics	Mean (SD)
Age	75.2 (8.0)
Gender	
Male	12,567,512 (43.2%)
Female	16,536,154 (56.8%)
Dual qualification for Medicare and Medicaid	
Yes	3,949,885 (13.6%)
No	25,153,813 (86.4%)

ARDS HOSPITAL DISCHARGES (2006-2012)

	Traumatic ARDS	Non-traumatic ARDS	ARDS
Total (N)	477,642	168,900	646,542
	Mean (SD)		
Age	76.7 (7.6)	79.7 (8.8)	78.2 (8.2)
Race	N (%)		
White	420,504 (88.0%)	139,211 (82.4%)	559,715 (86.6%)
Black	35,826 (7.5%)	18,699 (11.1%)	54,525 (8.4%)
Others	21,312 (4.5%)	10,990 (6.5%)	32,302 (5.0%)
Sex	N (%)		
Male	239,793 (50.2%)	71,991 (42.6%)	311,784 (48.2%)
Female	237,849 (49.8%)	96,909 (57.4%)	334,758 (51.8%)

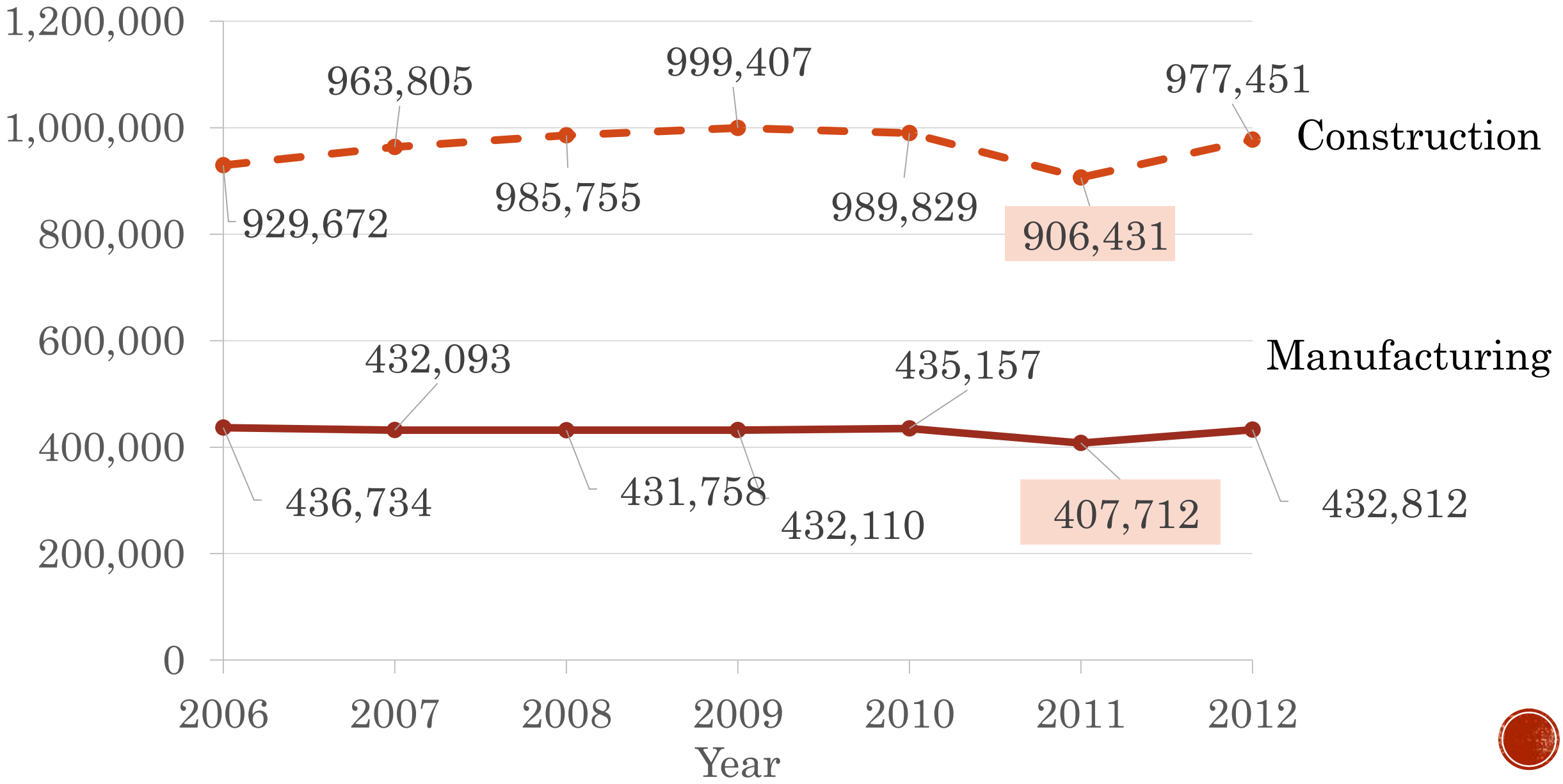
ARDS HOSPITAL DISCHARGES (2006-2012)

	Traumatic ARDS	Non-traumatic ARDS
Total (N)	477,642	168,900
	Mean (SD)	
Length of days in ICU	8.0 (10.5)	2.5 (4.9)
Length of stay in hospital	15.0 (13.7)	7.8 (7.8)

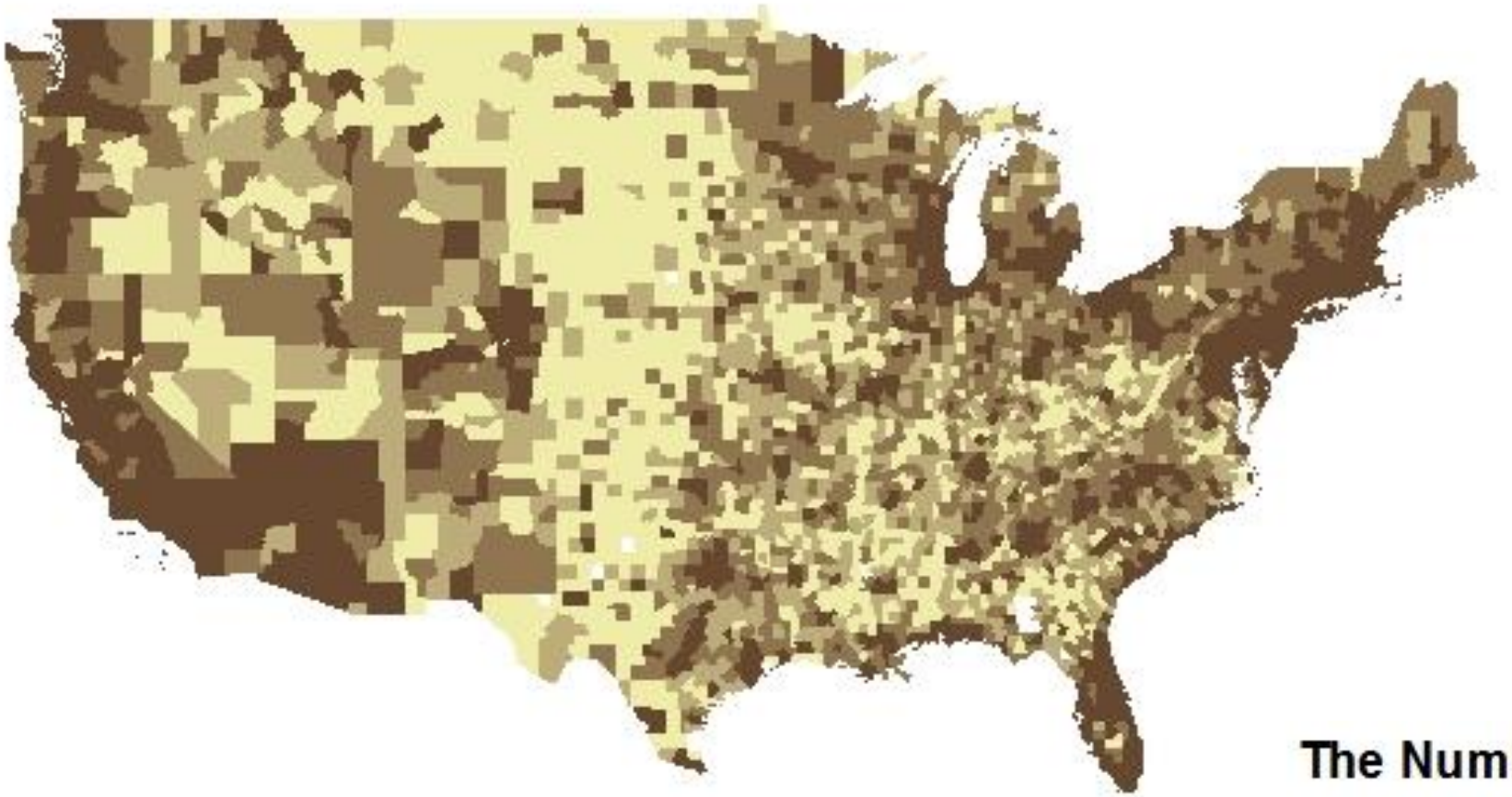
ARDS HOSPITAL DISCHARGES (2006-2012)

	Traumatic ARDS	Non-traumatic ARDS
Total (N)	477,642	168,900
Comorbidity	N (%)	
Sepsis		
No	241,156 (50.5%)	72,895 (43.2%)
Yes	236,486 (49.5%)	96,005 (56.8%)
Traumatic injury		
No	419,769 (87.9%)	163,944 (97.1%)
Yes	57,873 (12.1%)	4,956 (2.9%)
Pneumonia		
No	474,253 (99.3%)	148,746 (88.1%)
Yes	3,389 (0.7%)	20,154 (11.9%)
Aspiration		
No	476,409 (99.7%)	159,424 (94.4%)
Yes	1,233 (0.3%)	9,476 (5.6%)

Number of Industries (2006-2012)



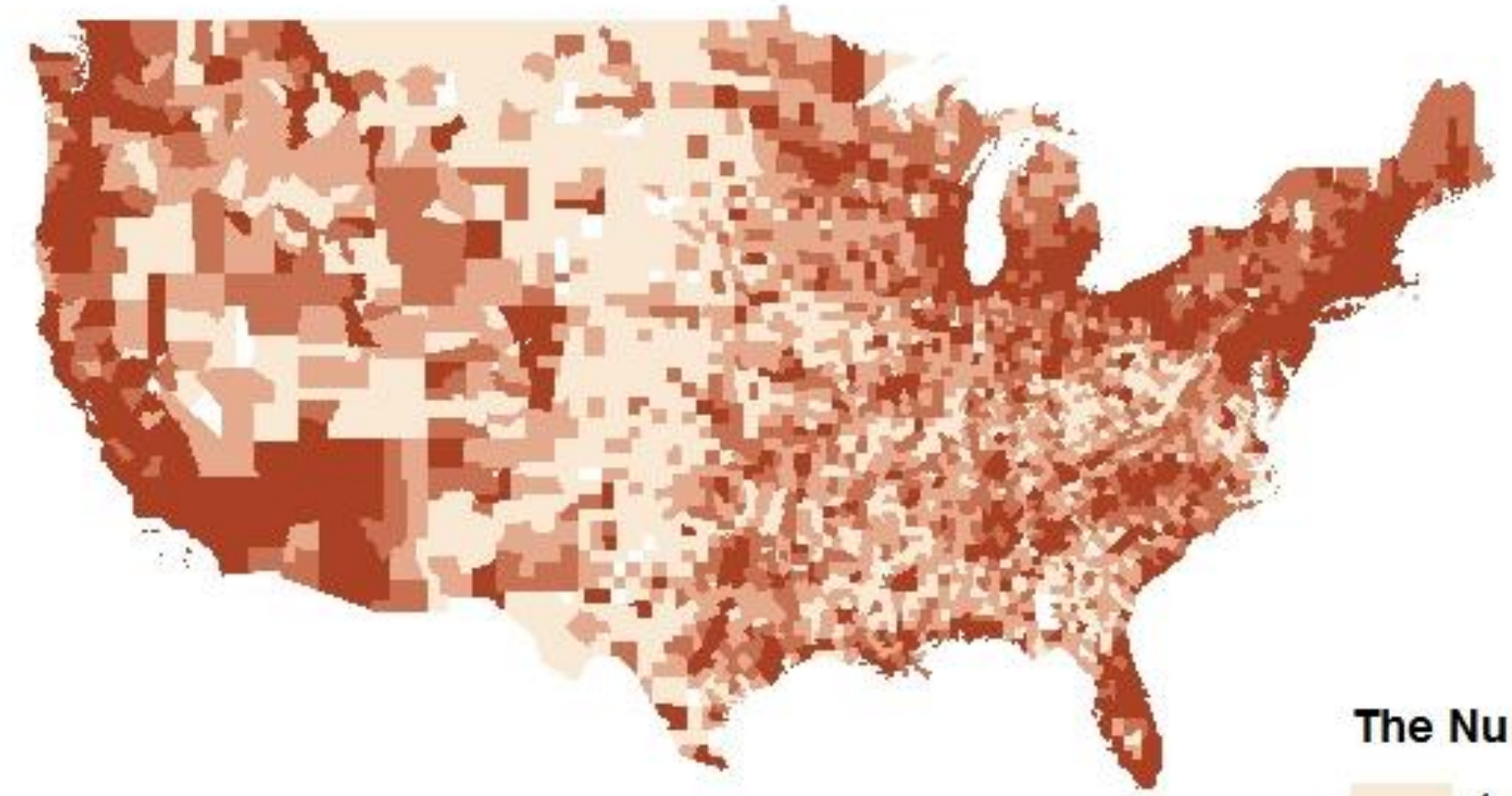
County-Level Construction Industry Distribution 2009



The Number of Construction Industry

- 1 - 30
- 31 - 80
- 81 - 300
- > 301

County-Level Manufacturing Industry Distribution 2009



The Number of Manufacturing Industry

- 1 - 15
- 16 - 40
- 41 - 100
- > 101

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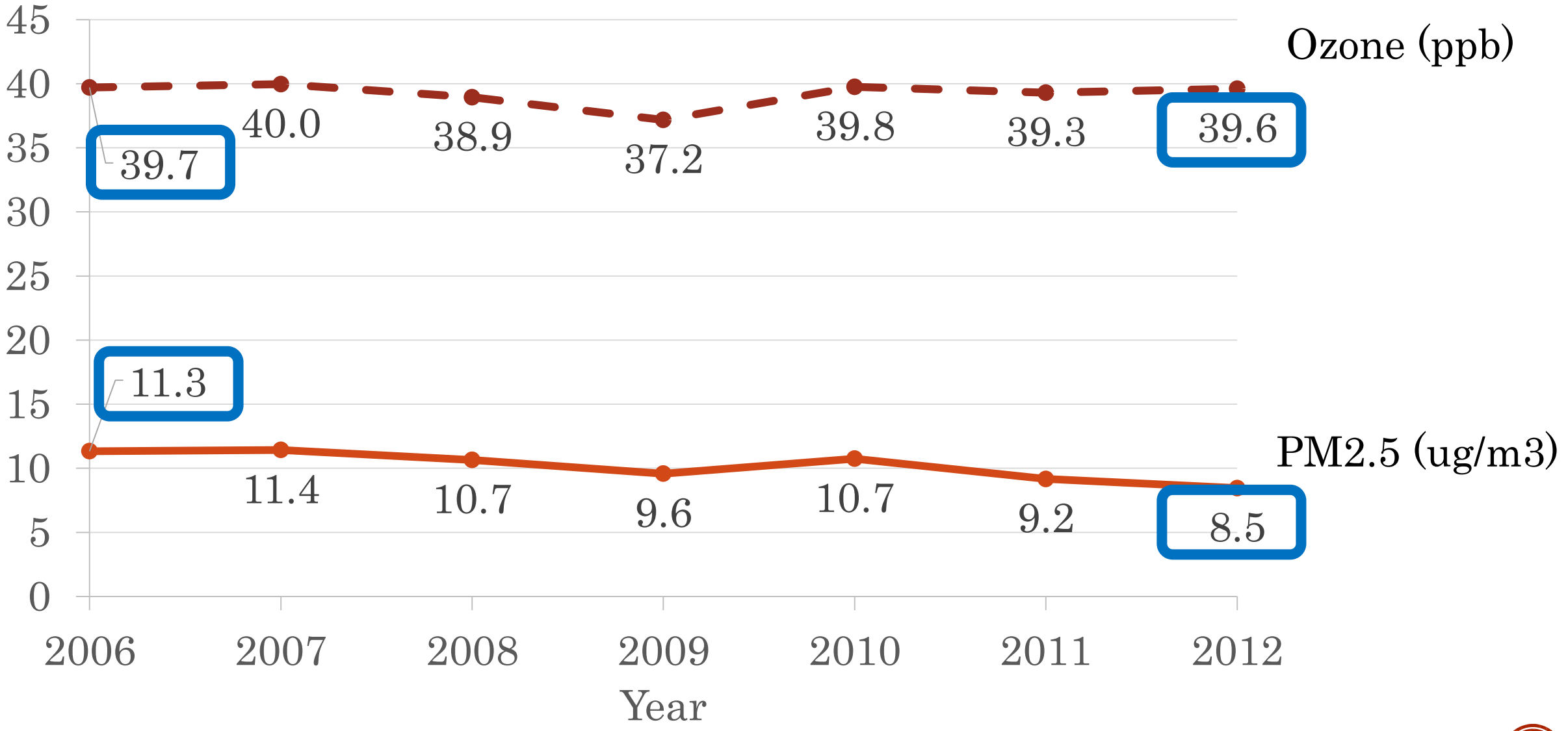
Yearly Average Air Pollution (2006-2012)



METHODS

ECOLOGICAL STUDY

- ARDS hospital discharges are rare events
- No information on job history for individuals in Medicare cohort

- **Investigating population level (zip-code)**
- **Rather focusing on density of companies (# of companies at each zip-code)**
- **Nation-wide observational study**

Original Contribution FREE

May 14, 2008

Coarse Particulate Matter Air Pollution and Hospital Admissions for Cardiovascular and Respiratory Diseases Among Medicare Patients

Roger D. Peng, PhD; Howard H. Chang, BS; Michelle L. Bell, PhD; et al

» Author Affiliations | Article Information

JAMA. 2008;299(18):2172-2179. doi:10.1001/jama.299.18.2172

- *Daily counts of county-wide emergency hospital admission*
- *County-specific estimated PM_{10} and $PM_{2.5}$ concentrations*
- *Overdispersed Poisson models were fit to the county specific data …*

JAMA

Original Contribution FREE

March 8, 2006

Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases

Francesca Dominici, PhD; Roger D. Peng, PhD; Michelle L. Bell, PhD; et al

» Author Affiliations | Article Information

JAMA. 2006;295(10):1127-1134. doi:10.1001/jama.295.10.1127

- *Daily counts of county-wide hospital admissions for …*
- *County-specific estimated $PM_{2.5}$ concentrations*
- *Overdispersed Poisson regression models were used for estimating county-specific RRs …*

STATISTICAL ANALYSIS

- **Exposure**: annual number of companies (construction and manufacturing) at zip-code level
- **Outcome**: annual counts of hospital discharges for ARDS at zip-code level
- **Confounders**: proportion of black, proportion of white, proportion of ever smokers, median household income, air pollution ($PM_{2.5}$ and Ozone)
- **Study period**: 2006-2012
- **Statistical model**: Quasi-Poisson Regression with random intercept (zip-code)

RESULTS

STUDY CHARACTERISTICS

Year 2006-2012	**Construction**	**Manufacturing**
Included zip-code	26,217	23,289
	Mean (SD)	
Number of companies	35.3 (47.8)	17.8 (31.0)
Counts of hospital discharges for total ARDS	2.5 (3.8)	2.7 (4.0)
PM2.5 (ug/m3)	10.2 (2.5)	10.3 (2.5)
Ozone (ppb)	39.1 (4.1)	38.9 (4.1)

CORRELATION COEFFICIENTS - CONSTRUCTION

	# of const.	ARDS	PM2.5	Ozone	%Black	%White	MHI	%Smoke
# of const.	1.00	0.74	0.14	-0.12	0.42	-0.39	0.39	-0.01
ARDS	0.74	1.00	0.19	-0.07	0.43	-0.38	0.22	0.00
PM2.5	0.14	0.19	1.00	0.08	0.24	-0.10	0.02	-0.06
Ozone	-0.12	-0.07	0.08	1.00	0.03	-0.06	-0.14	-0.07
%Black	0.42	0.43	0.24	0.03	1.00	-0.79	0.00	-0.03
%White	-0.39	-0.38	-0.10	-0.06	-0.79	1.00	0.04	0.14
MHI	0.39	0.22	0.02	-0.14	0.00	0.04	1.00	-0.05
%Smoke	-0.01	0.00	-0.06	-0.07	-0.03	0.14	-0.05	1.00

CORRELATION COEFFICIENTS - MANUFACTURING

	# of Mfg.	ARDS	PM2.5	Ozone	%Black	%White	MHI	%Smoke
# of Mfg.	1.00	0.68	0.16	-0.14	0.39	-0.40	0.24	-0.05
ARDS	0.68	1.00	0.18	-0.06	0.42	-0.38	0.21	0.00
PM2.5	0.16	0.18	1.00	0.10	0.23	-0.11	0.02	-0.07
Ozone	-0.14	-0.06	0.10	1.00	0.05	-0.06	-0.12	-0.07
%Black	0.39	0.42	0.23	0.05	1.00	-0.81	-0.03	-0.04
%White	-0.40	-0.38	-0.11	-0.06	-0.81	1.00	0.06	0.16
MHI	0.24	0.21	0.02	-0.12	-0.03	0.06	1.00	-0.06
%Smoke	-0.05	0.00	-0.07	-0.07	-0.04	0.16	-0.06	1.00

MULTIVARIABLE ANALYSIS

	Percent change (%) in hospital discharges for ARDS by 10 companies increase (95% CI)			
	Model 1	Model 1 + PM2.5	Model 1 + Ozone	Model 1 + PM2.5 + Ozone
Construction	0.66 (0.53-0.78)	0.70 (0.58-0.83)	0.66 (0.53-0.78)	0.71 (0.58-0.83)
Manufacturing	0.48 (0.30-0.65)	0.44 (0.26-0.62)	0.47 (0.29-0.65)	0.42 (0.24-0.60)

* Model 1: adjusting for proportion of black population, proportion of white population, proportion of ever smokers, median household income, and year

TRAUMATIC VS NON-TRAUMATIC ARDS

	Percent change (%) in hospital discharges for ARDS by 10 companies increase	
	Traumatic ARDS	Non-Traumatic ARDS
Construction	0.91 (0.77-1.06)	0.24 (0.02-0.46)
Manufacturing	0.36 (0.15-0.57)	0.54 (0.24-0.84)

Adjusting for yearly average PM2.5 (ug/m3), yearly average ozone (ppm), proportion of black population, proportion of white population, proportion of ever smokers, median household income, and year

SUMMARY

- Observed statistically significant associations between industries and ARDS hospital discharges

1) **0.7% increase** in hospital discharges for ARDS by 10 companies increase in annual **construction industry**: 0.9% increase for traumatic ARDS, 0.2% increase for non-traumatic ARDS
2) **0.4% increase** in hospital discharges for ARDS by 10 companies increase in annual **manufacturing industry**: 0.4% increase for traumatic ARDS, 0.5% increase for non-traumatic ARDS

- Consistent results after adjusting for air pollution: yearly average PM2.5 and ozone levels

STRENGTHS AND LIMITATIONS

Strengths

1) **Big data (0.3 million)** for investigating ARDS risk

2) **National level**

3) First study investigating **industry intensity and ARDS**

Limitations

1) No individual job history

Cannot conduct sensitivity analysis: workers vs non-workers

CONCLUSIONS

- The first observational study to examine the relationship between industry intensity and acute respiratory distress syndrome (ARDS) risk.
- Found significant evidence of ecological association.

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SCHOOL OF PUBLIC HEALTH

THANK YOU

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