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Agricultural Lung Diseases

Airway disorders

- Upper Airway Responses
- Asthma
- Asthma-like Syndrome
- Toxic Gas Inhalation
- Chronic Obstructive Airway Disease

Interstitial Diseases

- Organic Dust Toxic Syndrome (ODTS)
- Farmer's Hypersensitivity Pneumonitis
- Interstitial Fibrosis

AJRCCM Suppl: Nov '98

Pulmonary Effects of Agricultural Exposure to Inorganic Dusts

- Particulate matter exposure
  - Silica and silicates
- Respiratory morbidity and mortality associated with inorganic dust exposure
- Interstitial lung disease
- Idiopathic pulmonary fibrosis
- Chronic obstructive pulmonary disease
- Prevention

Western Agriculture is....Dry and Dusty

“Winds blowing over the barren lands churn up storms of dust… I sense what dust bowl veterans of the 30’s must have witnessed.”

“Even my unexposed skin wears a fine undergarment of dust; it penetrates most every crevice of my body”

Epitaph for a peach, 1996
David M. Masumoto
Central Valley farmer

Inorganic Dust and Dust Exposure in California (dry climate) Agriculture

Silica and Silicates in Agricultural Soils

- Crystalline silica (SiO_2).
  - Quartz, cristobalite, tridymite
  - 12% of land mass, ≤20+% of topsoil
- Silicates (SiO_2 + Mg, Ni, Fe, Al)
  - Talc, asbestos
  - 90% of land mass
- Amorphous silicates (SiO_2 + H_20)
  - In biologic systems, may be fibrous

Respirable dust sampler with cyclone

Personal Dust Exposure During Field Crop Farming-California

Operation	Cab	GM (mg/m^3)
Land plane	No	57.3
Disking	No	98.6
"	Yes	1.6
Fertilize	No	10.4
Plant	No	23.3
Harvest	No	39.1
"	Yes	1.6
Irrigate	No	2.2

Personal Dust Exposure (mg/m^3) Fruit, Nut, Dairy Farming - Calif.

Operation	GM (mg/m^3)
Fruit & Nut	
- Hand harvest	5.1
- Mechanical harvest	10.6
Dairy Farming	
- Feeding	25.9
- Manure removal	2.6
- Milking	0.7

Niewenhuysen, 1998

Airborne contaminants in rice and citrus farming (mg/m3)

	Rice Field Prep		Citrus Harvest	
	Avg	Range	Avg	Range
Total dust	**35.2**	11.1 - 72.1	**39.6**	19.5 -100.8
Resp. dust	**3.17**	1.77 - 5.24	**1.14**	0.01 - 5.1
Resp. quartz	**0.03**	0.02 - 0.04	**0.08**	0.01 - 0.2

Lawson '93

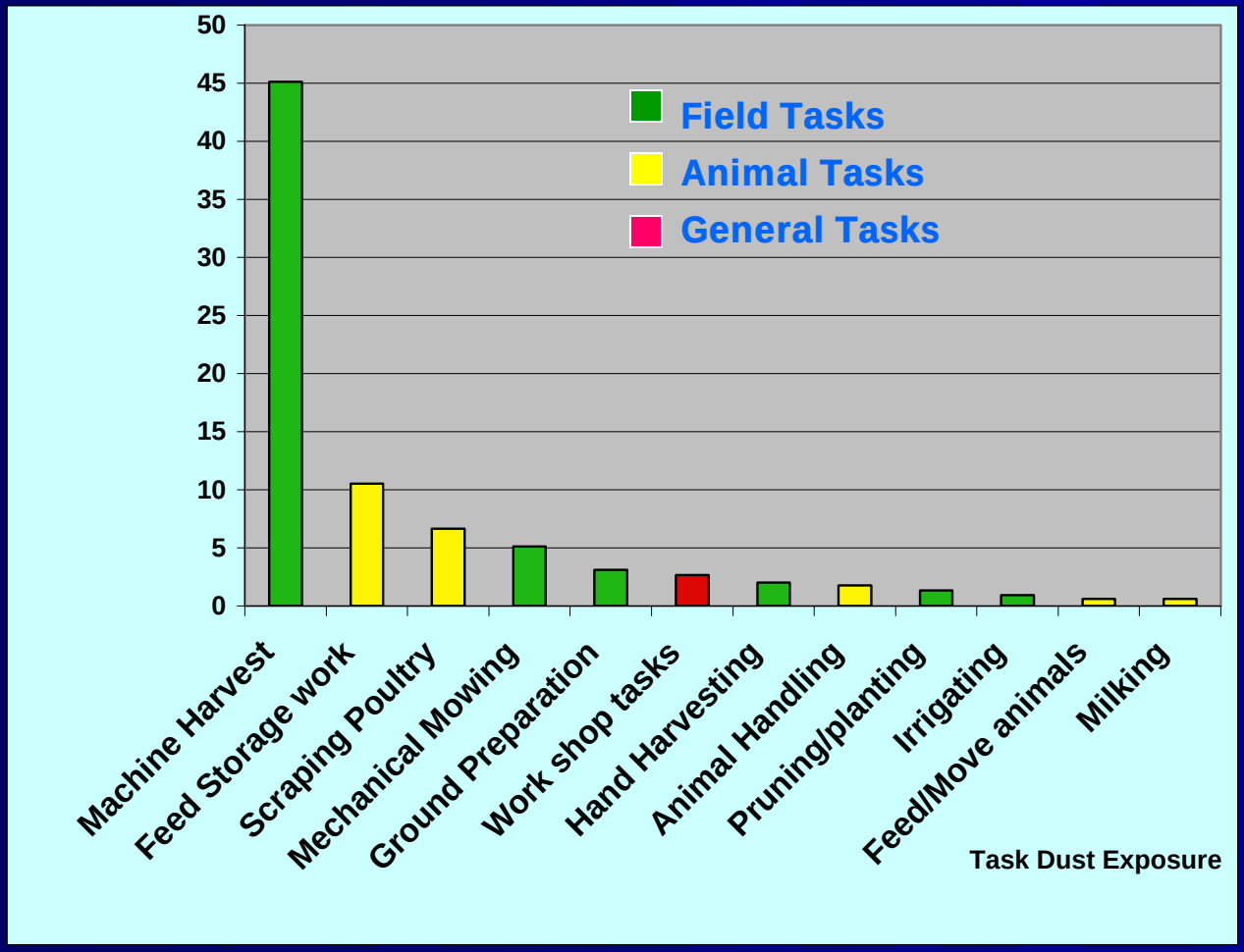
Inorganic Dust and Respiratory Disease in Agriculture

Demographics of Farmers in UC Davis FHS in 1993, (n = 1947)

Characteristic	Mean (SD)	Median
Age (Yrs)	54.4 (13.4)	54
		Percent
Sex (Female)	196	10.1
Ethnicity – White (n/Hispanic) - Hispanic - Asian	1645 120 89	84.5 6.2 4.6
Education < High School	186	9.5
Smoking Status – Never - Ex smoker - Current	1079 627 233	55.4 32.2 12.0

Ref: Schenker et al. JOEM 2005 47(12)

Personal measurement of Exposure to Inhalable dust by task: FHS

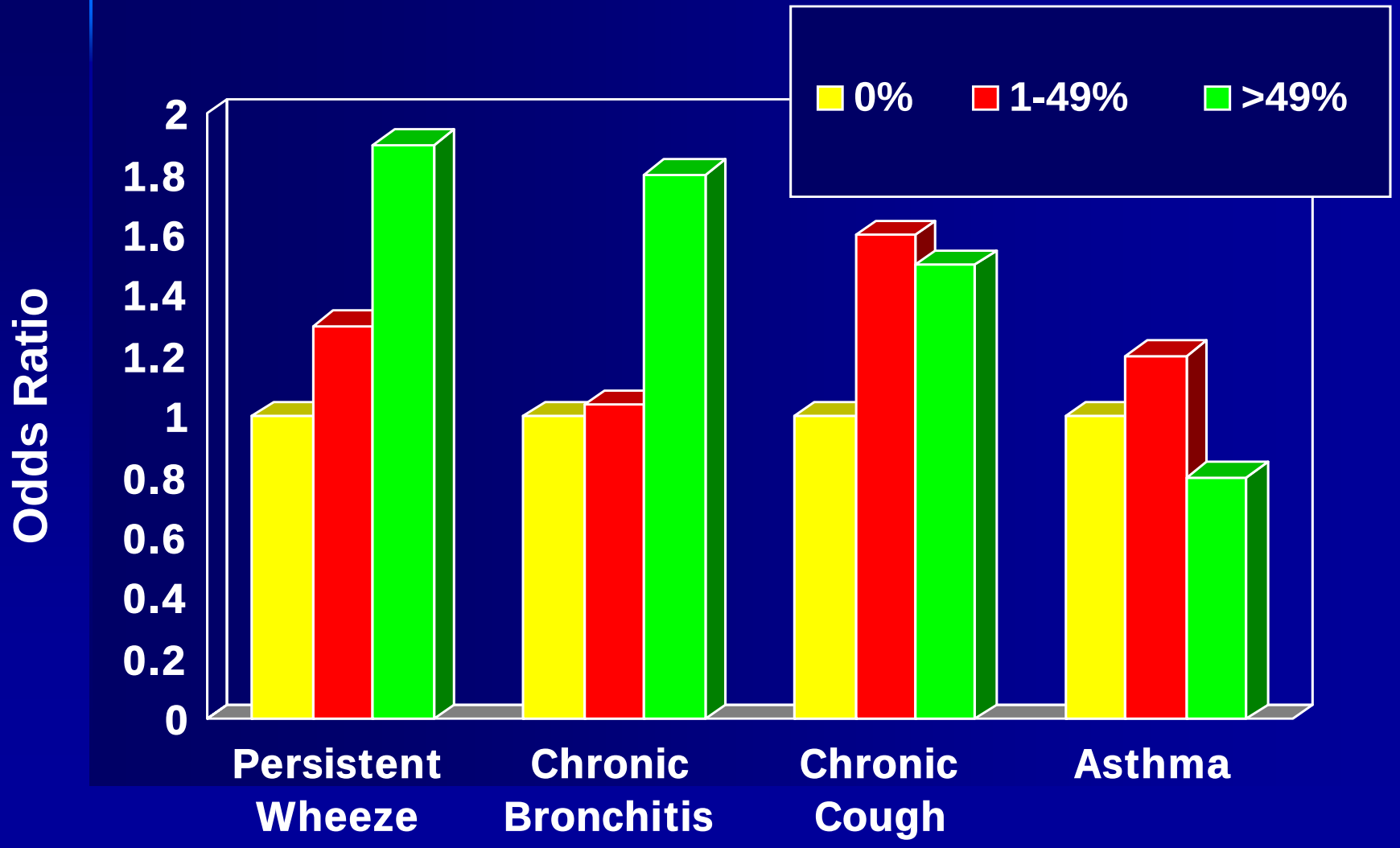


Ref: Nieuwenhuijsen MJ, et al. Ann Occup Hyg (1999) 43: 35-42

Exposures of Farmers in UC Davis FHS in 1993, (n = 1947)

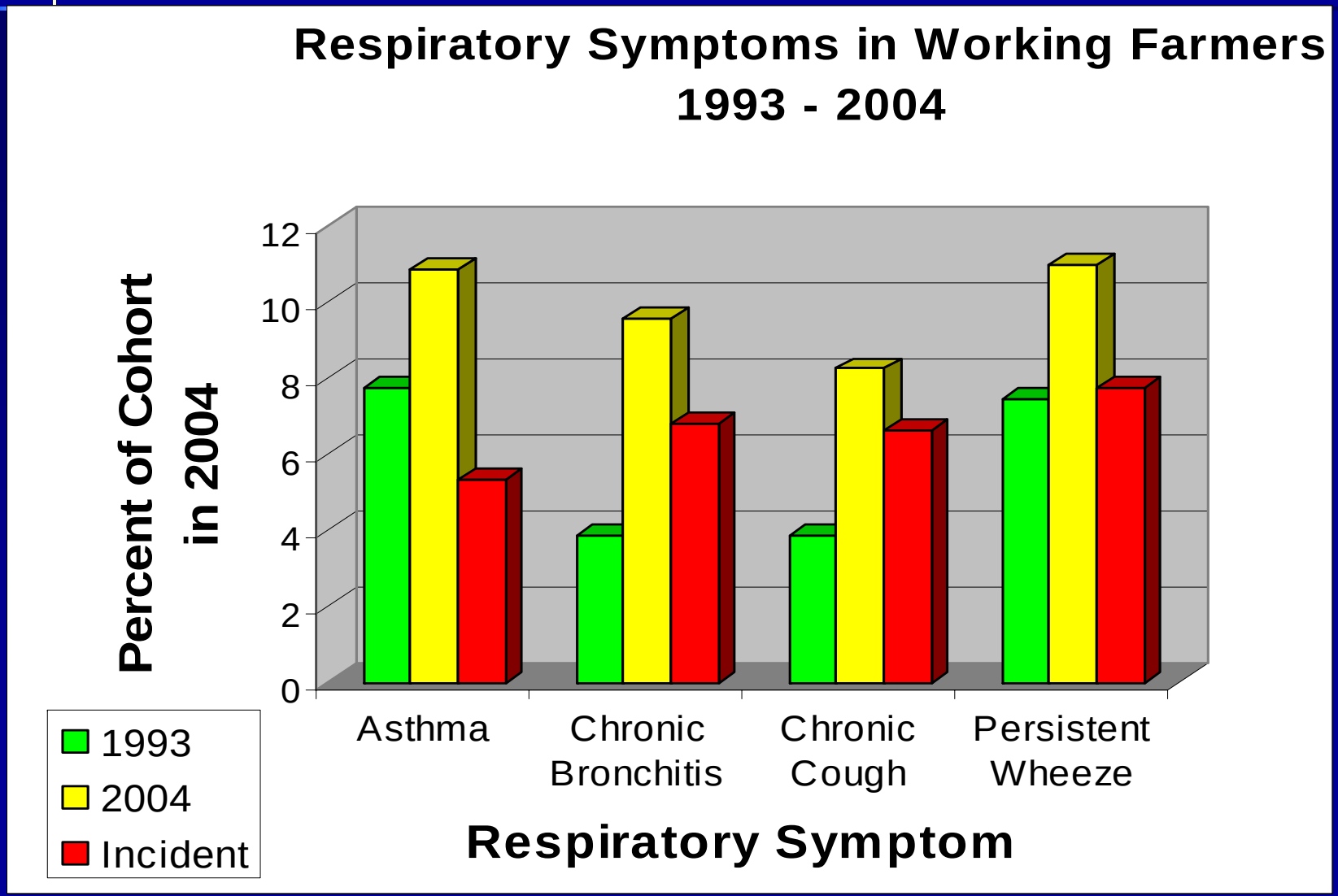
Exposure		N / 1947	Percent
Live on Farm		1407	72.3
Income from farming	<25%	659	33.9
	25-50%	318	16.4
	51-75%	142	7.3
	>75%	803	41.3
Farm type	Large Mixed	337	17.3
	Field	148	7.6
	Fruit	877	45.0
	Livestock	255	13.1
	Nursery	65	3.3
	Small mixed	232	11.9
	Vegetables	20	1.0
Percent time at dusty job - 0%		430	22.2
	1- 49%	1155	59.3
	> 50%	336	17.3

Odds Ratios* for Respiratory Symptoms by Percent Time at Dusty Job



*Logistic regression model, adjusted for age, smoking status, gender and other variables

Prevalent and Incident Respiratory Symptoms

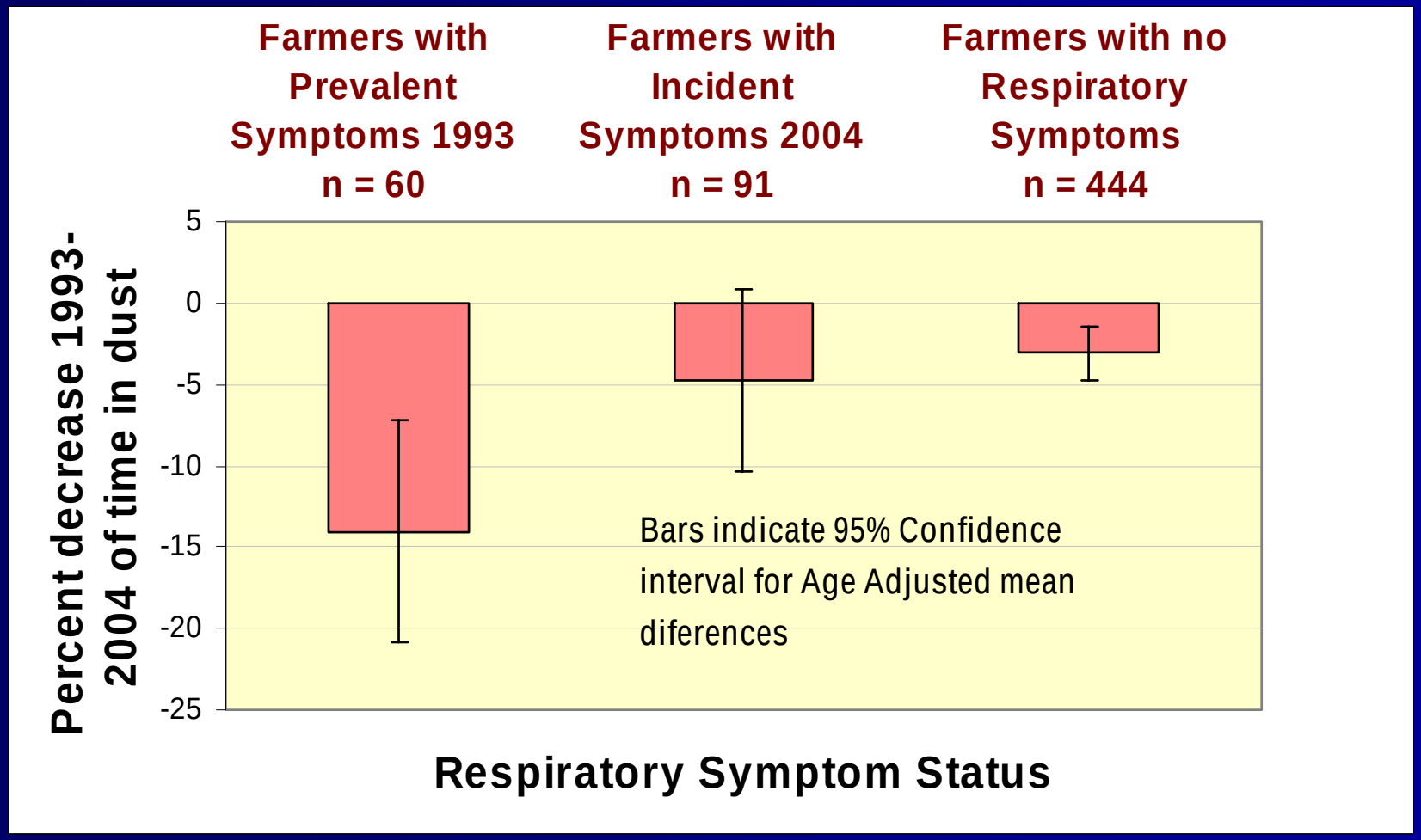


1993-2004 Incidence Odds Ratios for Respiratory Symptoms

Outcome	Exposure variable	Adjusted Odds Ratio	95% Confidence Interval
New Chronic Cough	Last Year Dust Rating (Continuous variable)	**1.192**	**1.05-1.35**
	Age (Continuous variable)	1.0	0.97-1.03
	*Smoking status		
	Current smoker	**4.86**	**1.84-12.8**
	Ex-smoker	1.4	0.68-2.88
New Chronic Cough	Last Year % Time in Dust (Continuous variable)	**1.015**	**1.003-1.028**
	Age	1.005	0.98-1.035
	*Smoking status		
	Current	**4.28**	**1.65-11.5**
	Ex-smoker	1.37	0.68-2.78

* Referent level of smoking = Never Smoked

Working Farmers 2004: Change in time exposed to dust 1993 - 2004



Pneumoconiosis

"Silicate Pneumoconiosis of Farm Workers"

- Seven California Central Valley residents
  - 5 vineyard workers, 1 farmer, 1 rural resident
  - 6/7 non-smokers
- Early to late interstititial inflammation and fibrosis
- No silicotic nodular granulomas
- SEM and EDXA of particles < 5 μm mostly silicates
  - (Si=68%, Al=27%, K=6%),
  - 5 - 10% SiO_2
  - Soil particle analysis similar composition

Sherwyn, Lab Invest 1979; 40:576

SILICATE PNEUMOCONIOSIS

- 100 autopsies in San Diego Zoo from 11 mammalian and 8 avian species.
- Crystal laden macrophages in alveoli and lymphatics. No nodules.
- Interstitial fibrosis in 20% of cases.
- SEM and TEM: 90% silicates.
- EDXA: mica and degradation products.
- Dust retention related to age, length of zoo stay.

Brambilla, AJP 1979; 96:149

Environmental Silicosis

- Equine Silicosis is frequently seen at UCD Veterinary Hospital
- Classical acute silicosis
- Environmental exposure

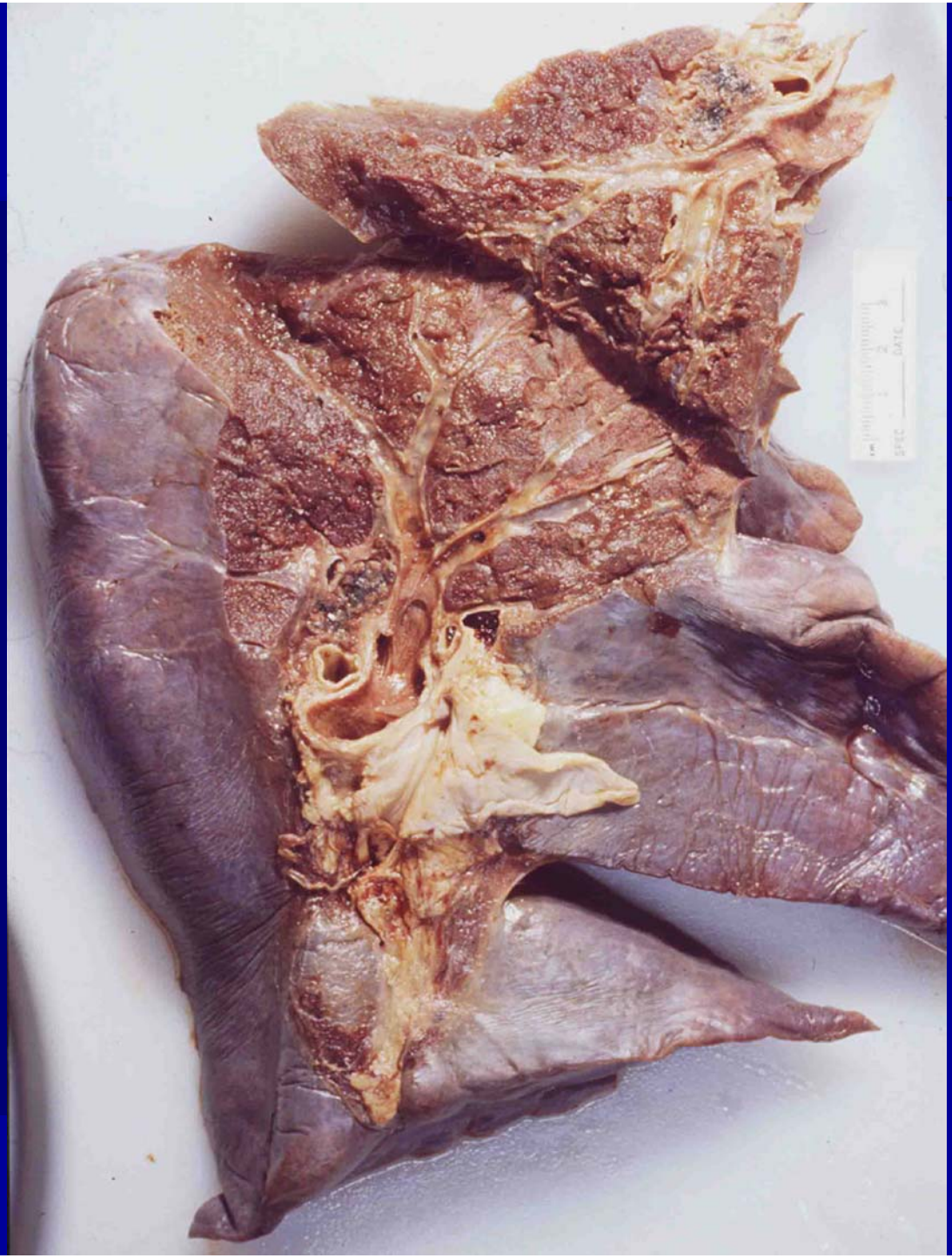
Berry, JVIM, 1991

Pneumoconiosis from Agricultural Dust Among California Farmworkers

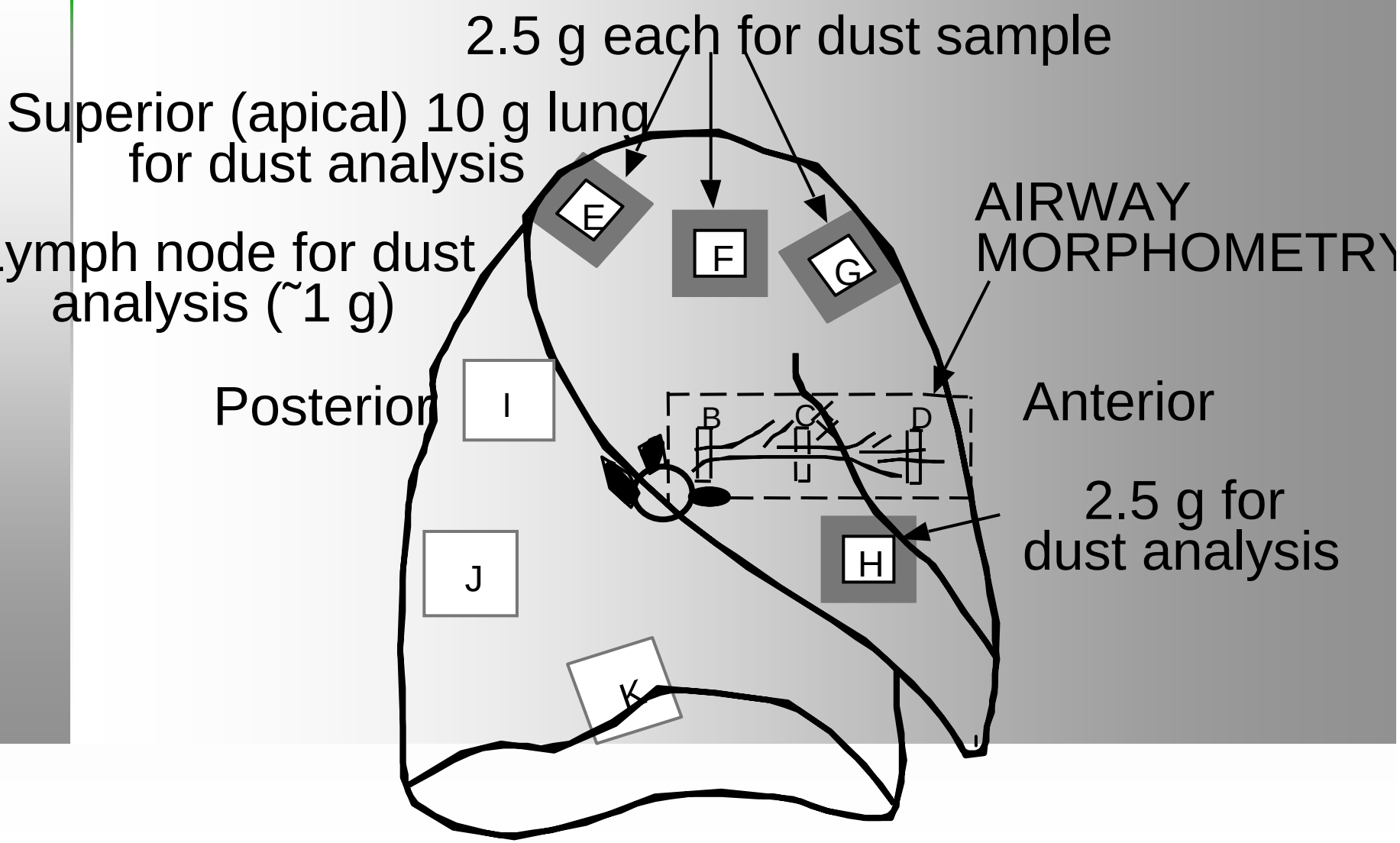
MB Schenker[1]
KE Pinkerton[1]
V Vallyathan[2]
F Green[3]
.....

[1]University of California at Davis
[2]NIOSH, Morgantown, WV
[3]University of Calgary

Autopsy specimen of left lung showing left mainstem bronchus and dissection of distinct airways



Sampling Strategy - Dust Analysis

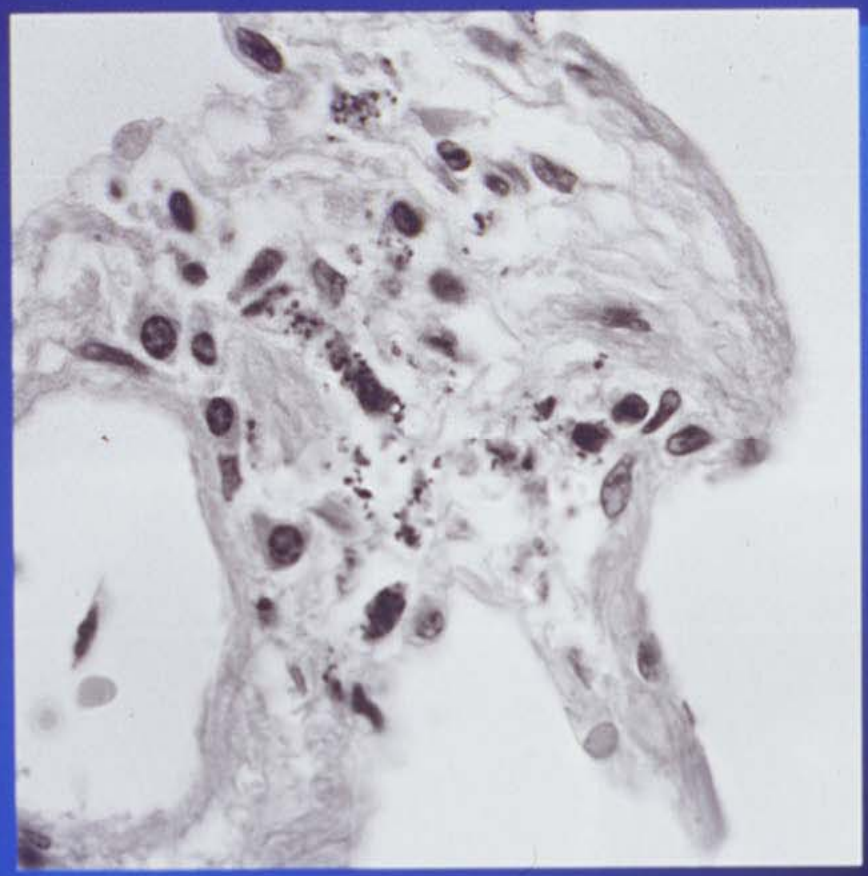


Particle Size and Mineral Characteristics in Farmworker Lungs

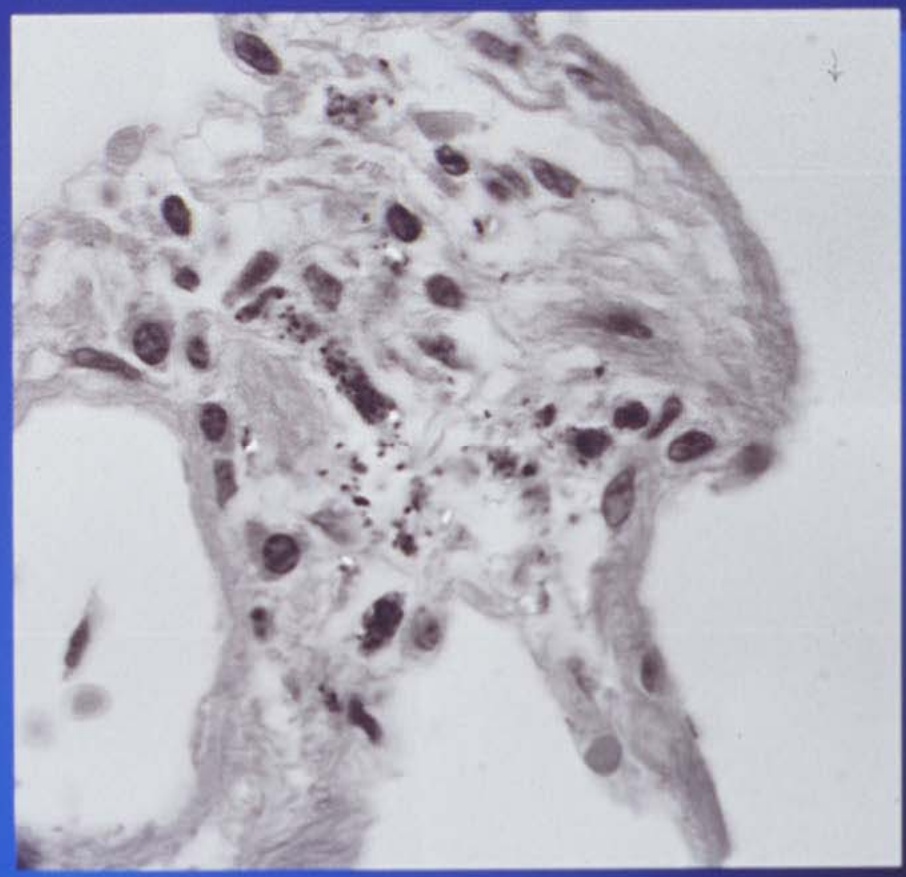
	Case 1	Case 2	Case 3	Case 4	Mean
Diameter (μ)*	0.60	0.66	0.68	0.60	0.635
Crystalline Silica**	13.87	15.85	17.14	20.42	16.82
Aluminum Silicates**	72.36	68.50	70.93	70.72	70.63
Other Silicates**	10.89	13.78	7.10	8.36	10.03
Endogenous**	2.88	1.87	4.83	0.50	2.52

*Median.

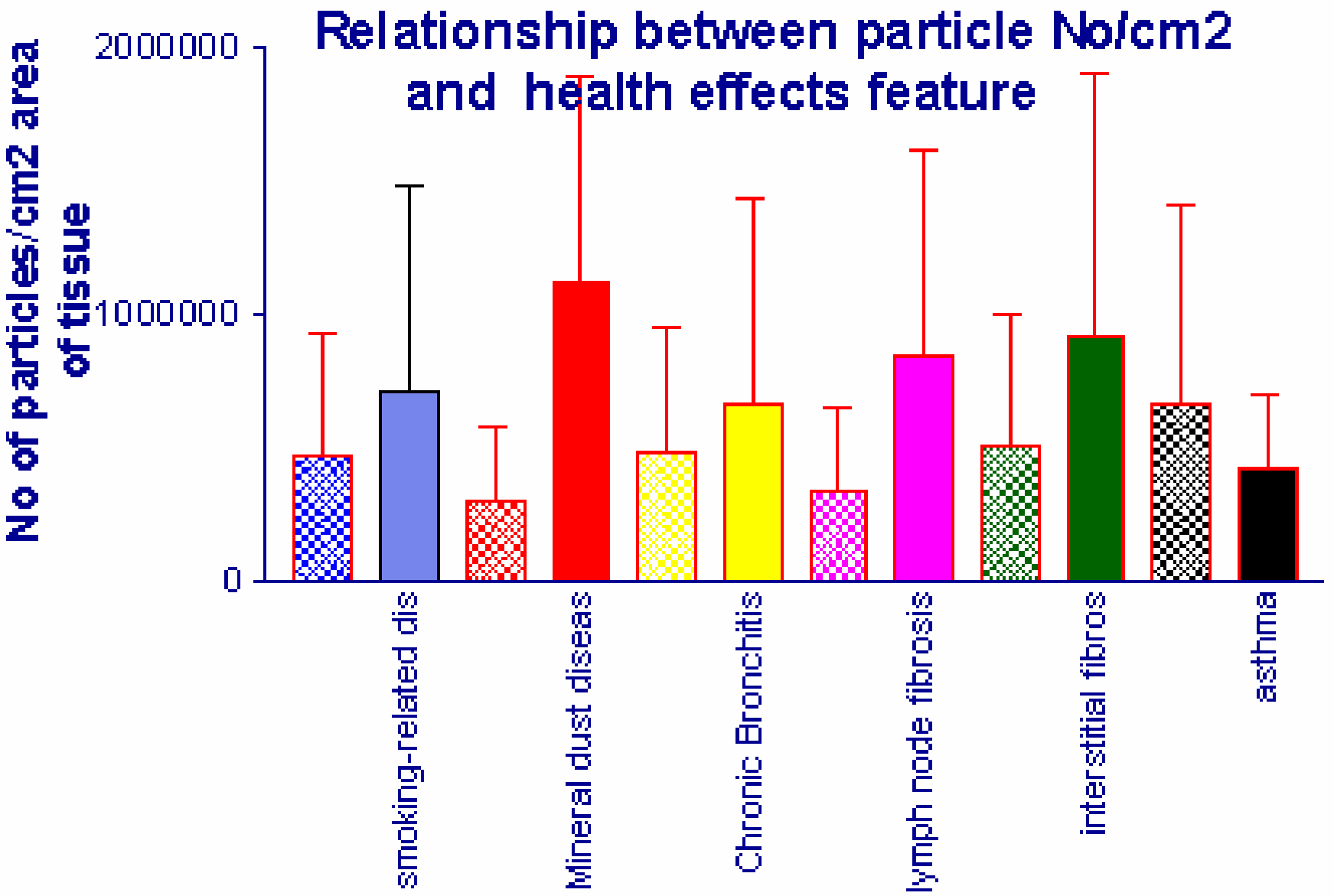
**Percent concentration of minerals by number determined by x-ray spectrometric analysis of 1000+ particles.



Without Polarizing Filter



With Polarizing Filter

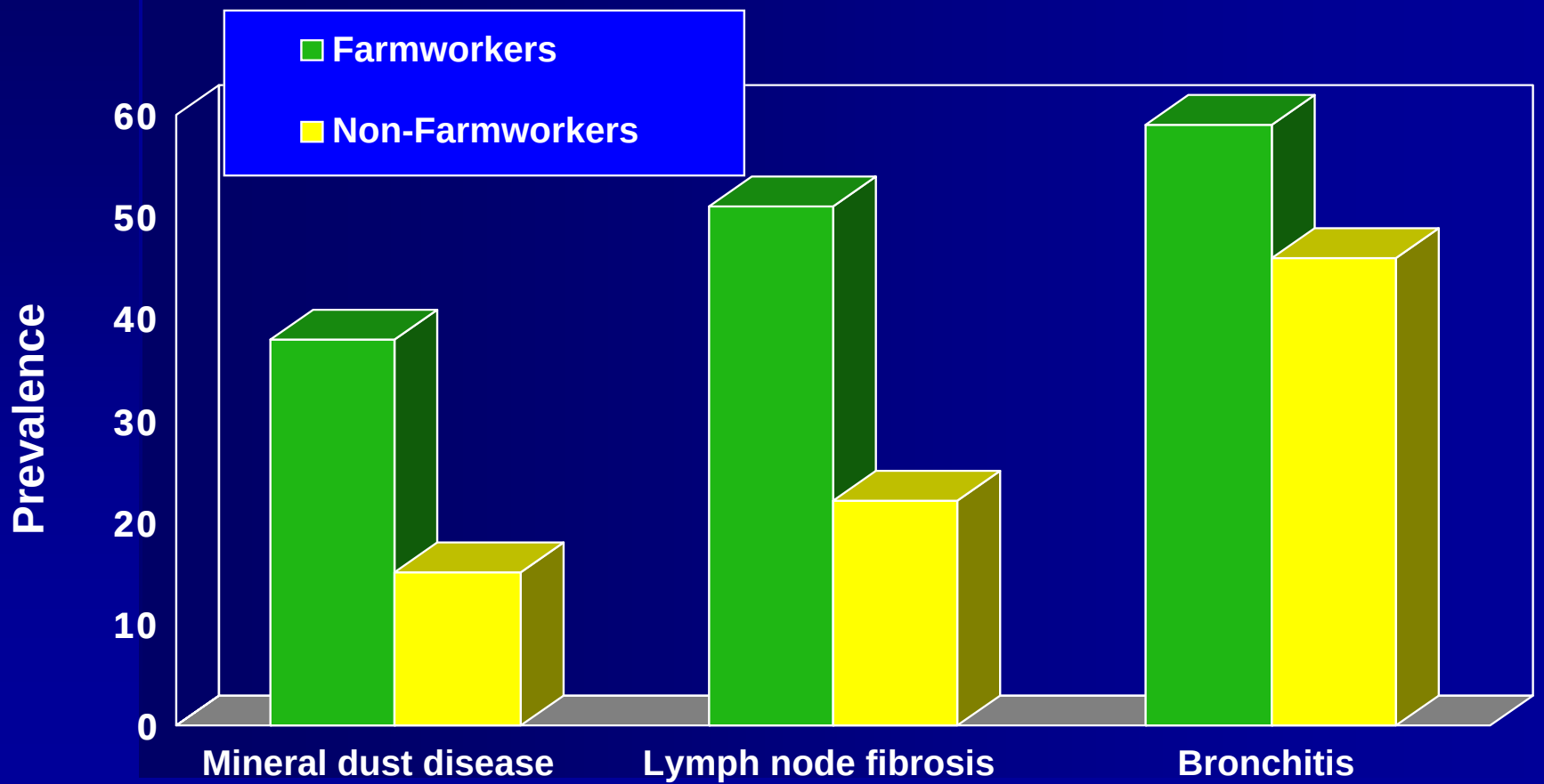

Relationship between particle No/cm2 and health effects feature
No of particles/cm2 area of tissue
2000000
1000000
0
smoking-related dis
Mineral dust diseas
Chronic Bronchitis
lymph node fibrosis
interstitial fibros
asthma

Sample Demographics

	Farmworkers	Non-farmworkers
Population*	39	41
Smokers	54%	51%
Age (25 - 75%ile)	36 (23-40)	30 (21-36)

* Unknown farm working status, n=6

Histologic Findings in Farmworkers vs. non-farmworkers (n=86)



Idiopathic Pulmonary Fibrosis

Risk Factors for Idiopathic Pulmonary Fibrosis: A Multicenter Case-Control Study

- 16 referral centers in 15 states
- Ages 20-75
- 248 cases, 491 controls

Exposure	O.R.	95% C.I.
Farming*	1.6	1.0 - 2.5
Livestock*	2.7	1.3 - 5.5
Vegetable/animal dust	4.7	2.1 - 10.4

*Interaction w/ smoking

Baumgartner, AJE 152; 2000

Case-Control Studies of Idiopathic Pulmonary Fibrosis

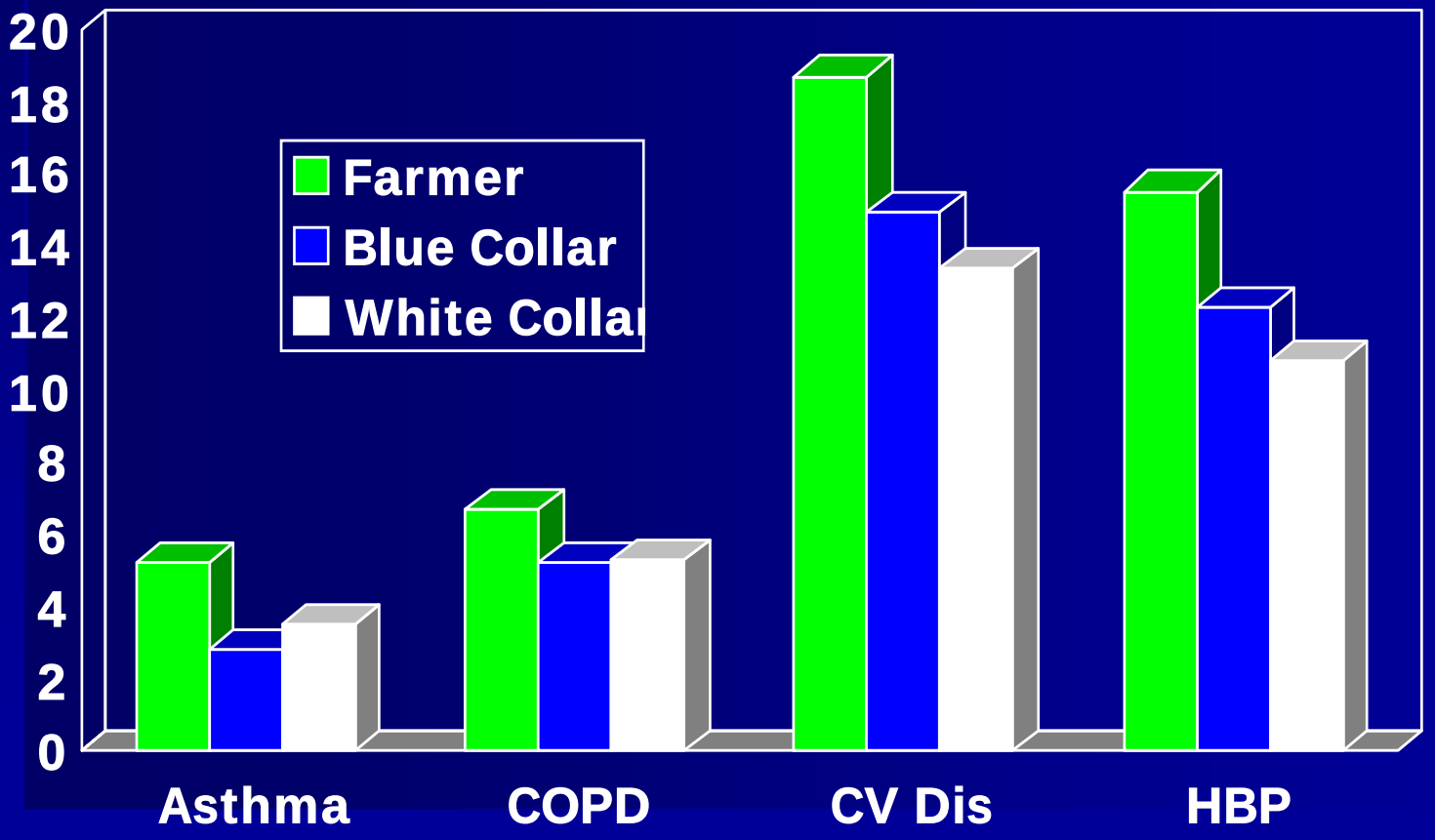
Occ/Exp	U.S. (n=248)	UK (n=218)	Japan (n=86)	England (n=40)
Farm/Ag	1.6*		3.0*	
Cattle	2.7*			10.9*
Stone/sand	3.9*	1.8*		0.9
Wood dust	1.6	1.7*		2.9

Chronic Obstructive Pulmonary Disease

Occupations Causing Chronic Obstructive Airway Disease

Occupation	CB	CAO	Emp.
Coal mining			
Gold mining			
Hard rock mining			
Asbestos work			
Foundry work			
Welding	±		
Grain work			
Cotton work			
Farming (e.g. swine)			

Age-Adjusted Prevalences for Chronic Conditions: NHIS, 1986-90



Brackbill, AJE, 1994

California Occupational Mortality, 1979-81: Agriculture, Males

Cause	SMR	95% C.I.
All Causes	139	135 - 143
Falls, machinery	306	249 - 363
Urinary system	182	115 - 250
Cirrhosis	152	133 - 171
COPD	134	106 - 163
Cerebrovascular	128	105 - 151
Lung Cancer	81	69 - 92


Thank you