Black Lung

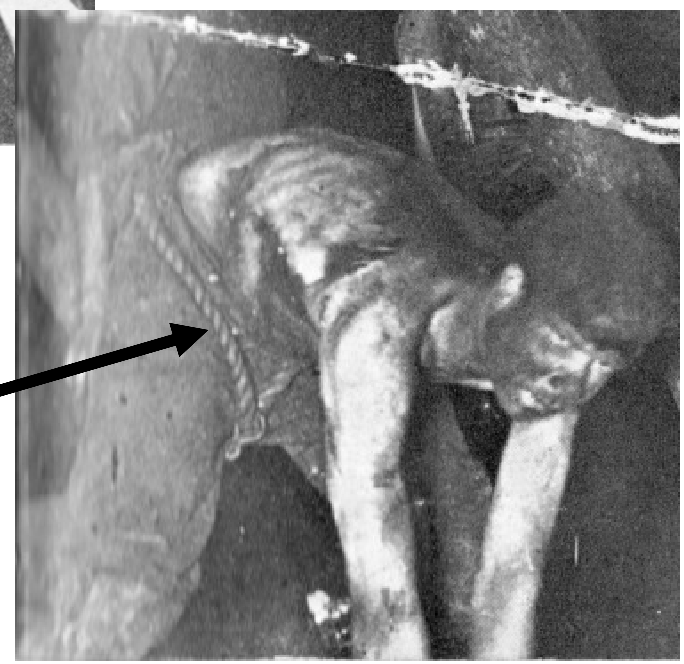
January 12, 2009

National Institute for Occupational Safety and Health

NIOSH

Who am I?

- Name: Michael Attfield PhD
- Degrees: University of Wales and WVU
- Current employment: Branch Chief, Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health, Morgantown, WV (1977 -)
- Prior employment: Team leader, Institute of Occupational Medicine, Edinburgh, Scotland (1969 – 1977)
- 40 years scientific research experience with coal mining-related lung diseases



Somerset Coalfield,
England
Carting boy’s harness
(guss and crook)

50th wedding anniversary, 1971

Black Lung

- Collection of diseases
  - **Pneumoconiosis**
  - Chronic obstructive pulmonary disease
  - Emphysema
- Pneumoconiosis
  - Fibrotic diseases of the lungs caused by inhalation of dusts
  - Coal workers’ pneumoconiosis (CWP), from coal mine dust
  - Silicosis, from silica dust
  - Both can lead to disability and premature mortality
  - Very difficult to distinguish between them on the x-ray

Normal

‘Simple’ CWP

PMF

Progressive massive fibrosis
Complicated pneumoconiosis

Pneumoconiosis is not caused by smoking!

… It is concluded that the main variable determining the development of simple pneumoconiosis is exposure to airborne dust, and that this effect is not modified appreciably by whether or not coal miners smoke.

SMOKING AND COALWORKERS' SIMPLE PNEUMOCONIOSIS

M. Jacobsen, J. Burns and M. D. Attfield

Institute of Occupational Medicine, Edinburgh, Scotland

Disease Prevention

- Primary disease prevention
  - Dust control
  - Alternatives
  - Ventilation
  - Respirators
- Secondary disease prevention
  - Early detection of disease and reduction/elimination of further exposure

NIOSH coal miner programs

- NIOSH runs two related programs for worker monitoring for pneumoconiosis
  - Regular program – mine-based using clinics to obtain x-rays
  - Enhanced program – community-based using NIOSH mobile van

NIOSH coal miner programs

- Both programs have two major uses –
  - Secondary disease prevention through entitlement to a low dust working environment if pneumoconiosis is seen
  - Population surveillance data to monitor effectiveness of dust control, identify problems, and assess trends.

Recent quote

- "After a couple of years, something changed. I began to see the type of disease that was only in the textbooks -- this massive fibrosis, where the lung is basically destroyed. It's nothing but black scar tissue. I was incredulous. And it was young people. It wasn't the older miners. I thought, something is wrong here. We decided we'd better do some research."

Dr. Lee Petsonk, NIOSH, retired

ORIGINAL ARTICLE

Rapidly progressive coal workers' pneumoconiosis in the United States: geographic clustering and other factors

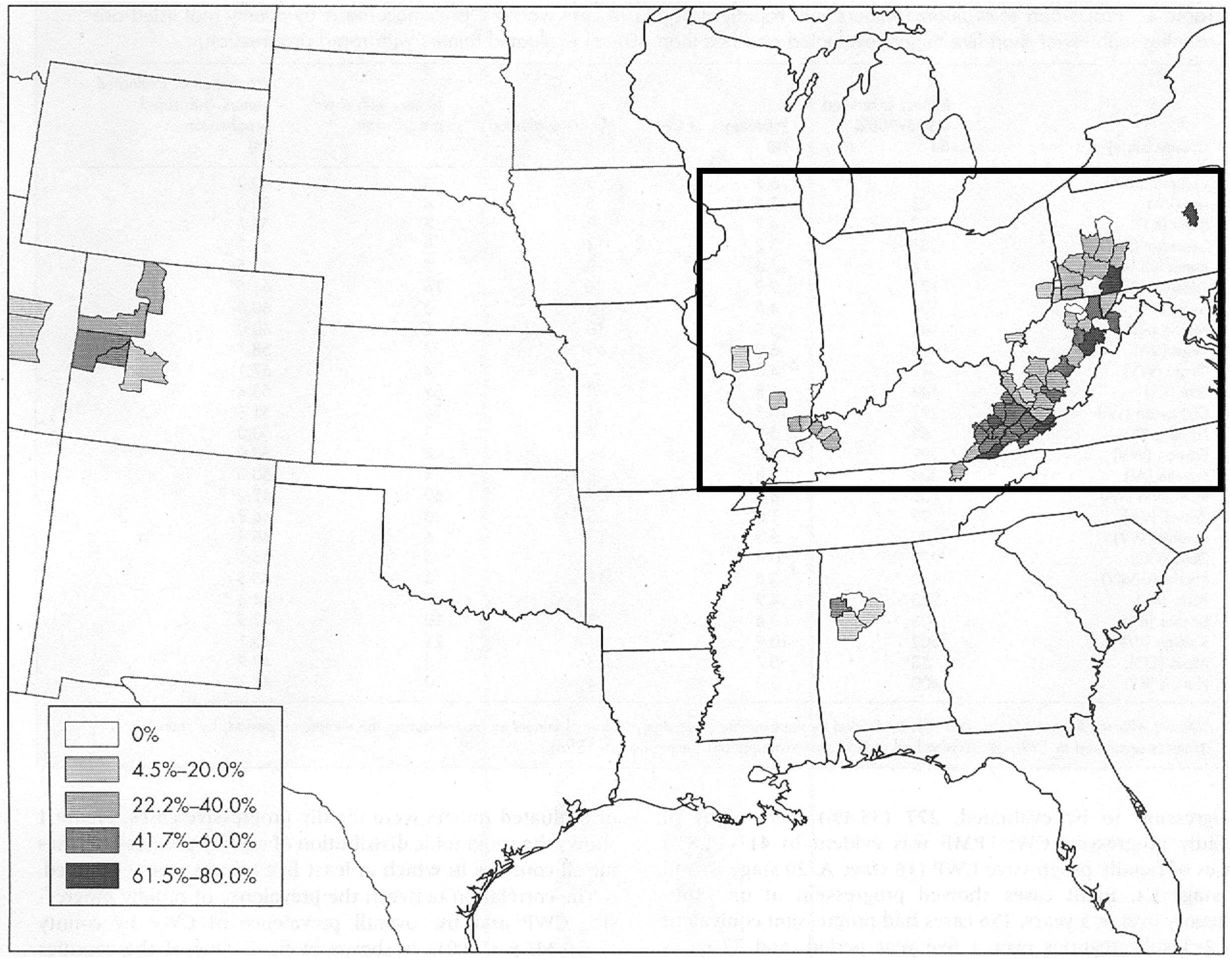
V C dos S Antao, E L Petsonk, L Z Sokolow, A L Wolfe, G A Pinheiro, J M Hale, M D Attfield

Occup Environ Med 2005;**62**:670–674. doi: 10.1136/oem.2004.019679

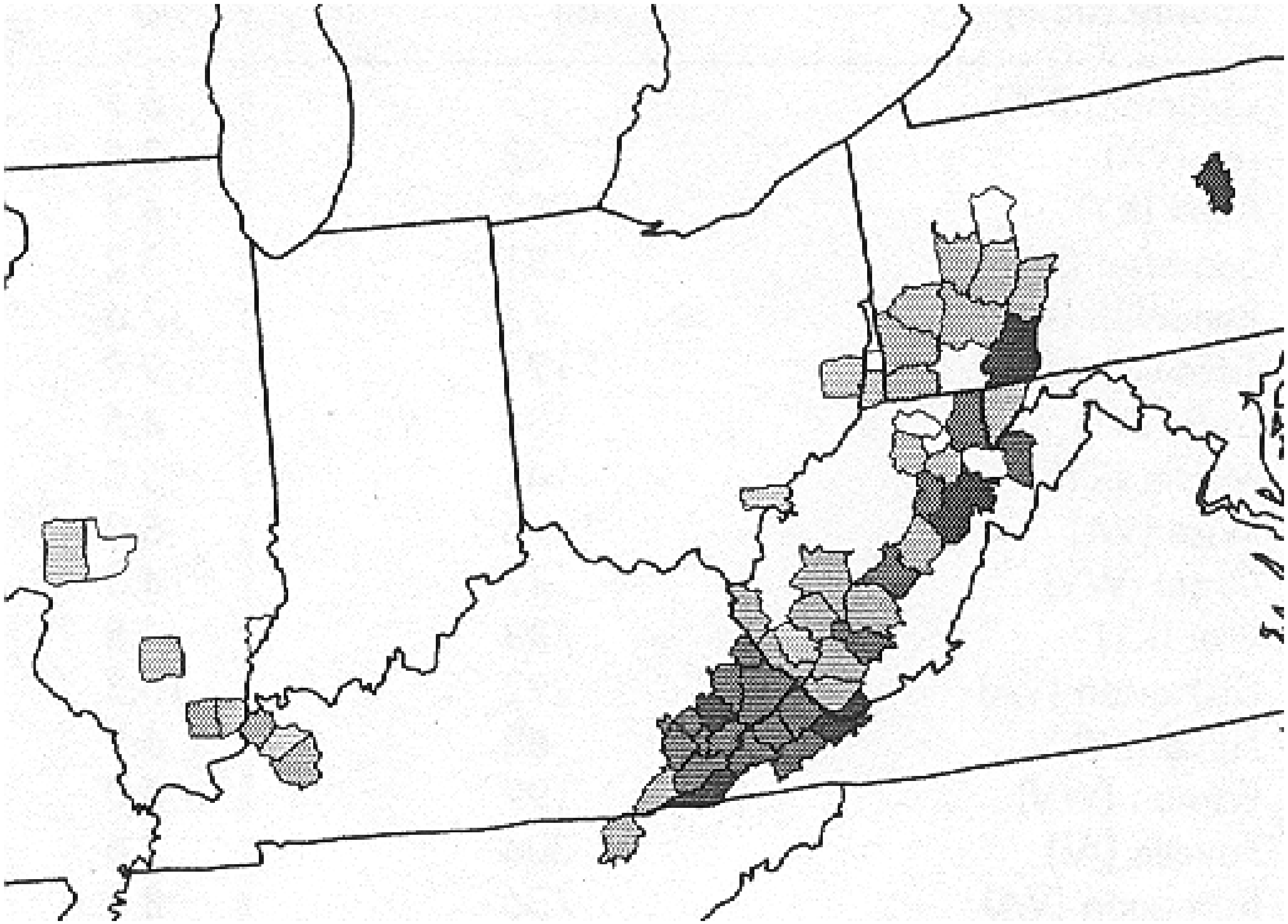
See end of article for authors' affiliations

Background: Despite significant progress made in reducing dust exposures in underground coal miners in the United States, severe cases of coal workers' pneumoconiosis (CWP), including progressive massive fibrosis (PMF), continue to occur among coal miners.
Aims: To identify US miners with rapidly progressive CWP and to describe their geographic distribution and associated risk factors.
Methods: Radiographic evidence of disease progression was evaluated for underground coal miners examined through US federal chest radiograph surveillance programmes from 1996 to 2002. A case of rapidly progressive CWP was defined as the development of PMF and/or an increase in small opacity profusion greater than one subcategory over five years. County based prevalences were derived for both

CWP hot spot areas



CWP Hot Spot Areas



CDC

MMWR

Morbidity and Mortality Weekly Report

Weekly August 25, 2006 / Vol. 55 / No. 33

Advanced Cases of Coal Workers' Pneumoconiosis — Two Counties, Virginia, 2006

This report describes 11 newly identified cases of advanced coal workers' pneumoconiosis (CWP), including progressive massive fibrosis (PMF), in working coal miners from Lee and Wise counties in southwestern Virginia. PMF is a disabling and potentially fatal form of CWP, an occupational lung disease caused by the inhalation of coal mine dust. The continuing occurrence of advanced forms of CWP emphasizes the importance of comprehensive measures to control coal mine dust effectively and reduce the potential for inhalation exposures in coal mining.

procedures. Radiographs are classified by NIOSH-certified B Readers according to the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses (*4*).

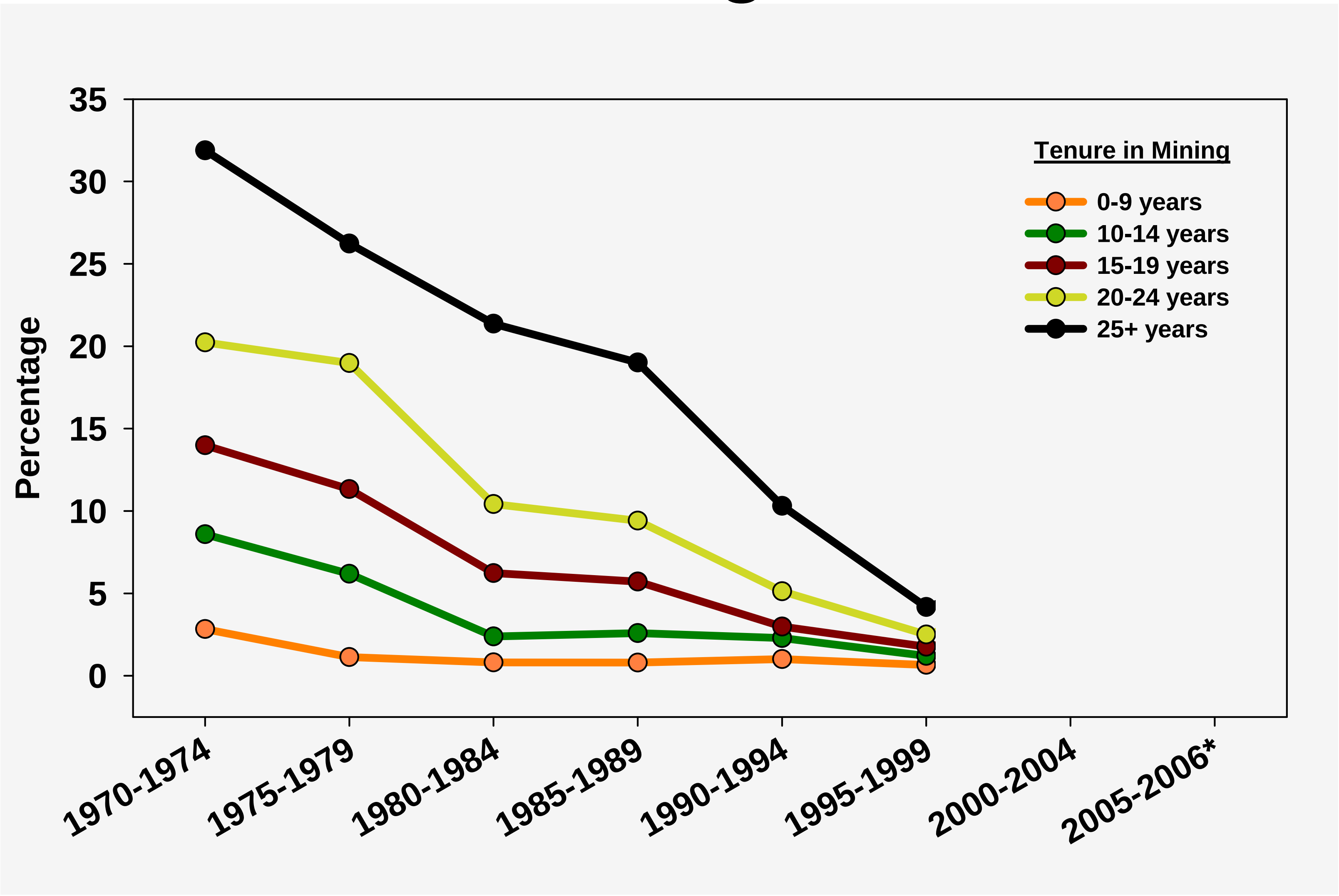
In March and May 2006, a total of 328 (31%) of the estimated 1,055 underground coal miners currently employed in Lee and Wise counties in Virginia were examined in ECWHSP surveys. The mean age of examined miners was 47 years (range: 21–63 years), and their mean tenure working in underground coal mines was 23 years (range: 0–41 years). A total of 216

CDC
MMWR
Morbidity and Mortality Weekly Report
Weekly July 6, 2007 / Vol. 56 / No. 26

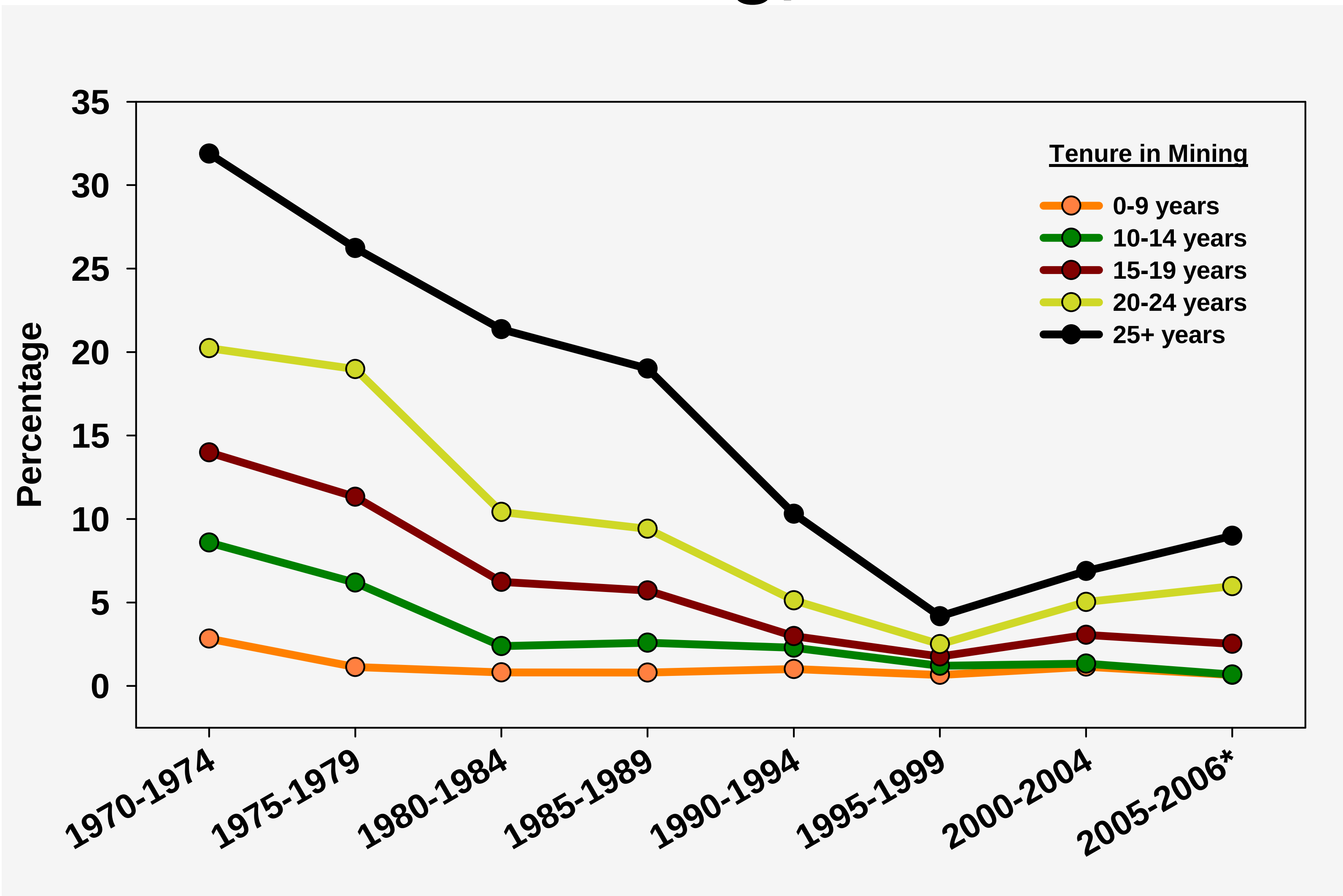
Advanced Pneumoconiosis Among Working Underground Coal Miners — Eastern Kentucky and Southwestern Virginia, 2006

Current regulations for U.S. underground coal mines, mandated by federal legislation in 1969 and amended in 1977, include provisions to prevent the occurrence of pneumoconiosis* (*1*). However, in 2005 and 2006, clusters of rapidly progressing and potentially disabling pneumoconiosis were reported in certain geographic areas (*2,3*). In response to these reports, CDC's National Institute for Occupational Safety and Health (NIOSH) instituted field surveys conducted under the Enhanced Coal Workers' Health Surveillance Program (ECWHSP).† This report describes the results of those sur-

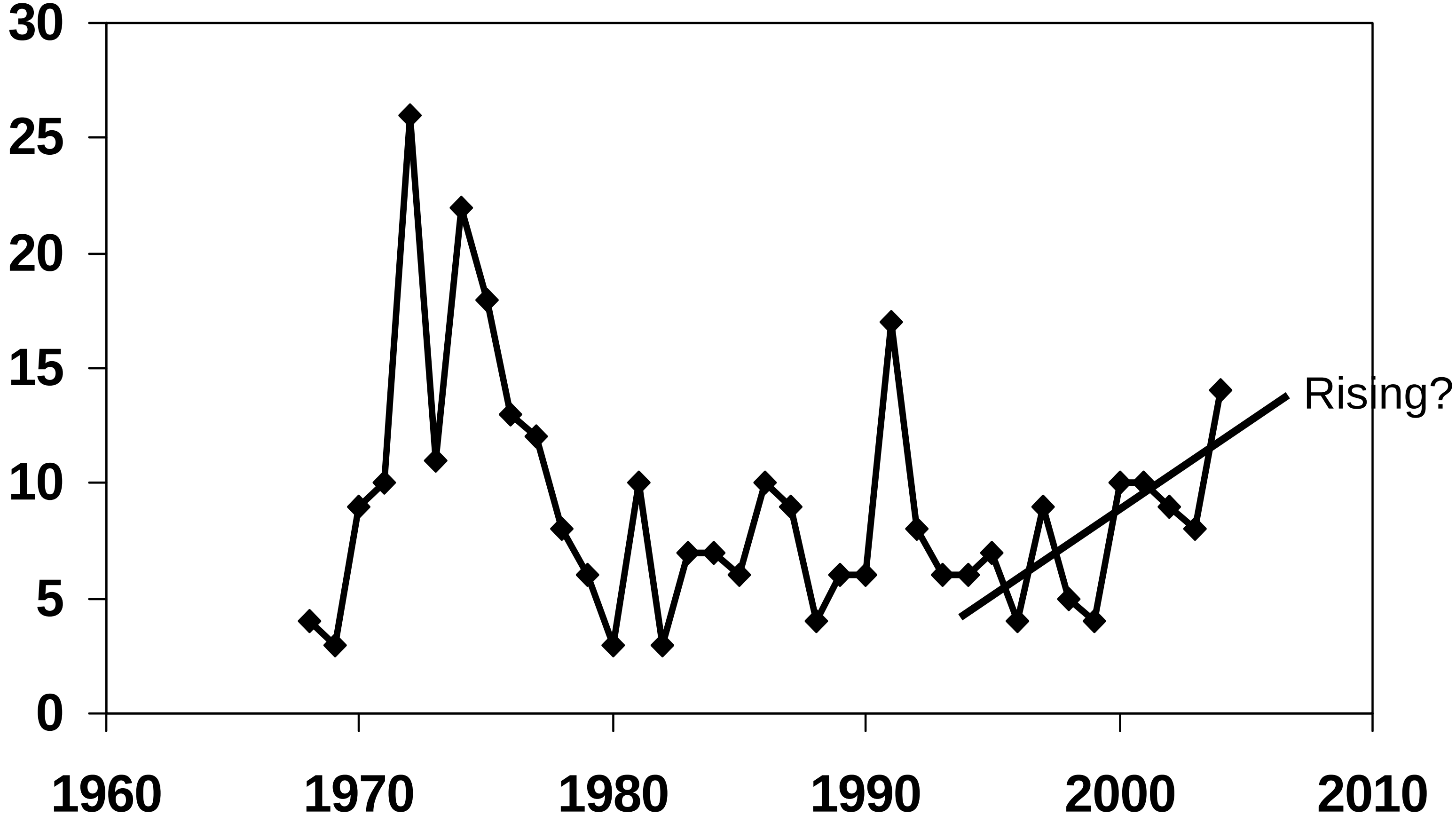
Percent of miners with CWP by tenure in mining, 1970-2006



Percent of miners with CWP by tenure in mining, 1970-2006

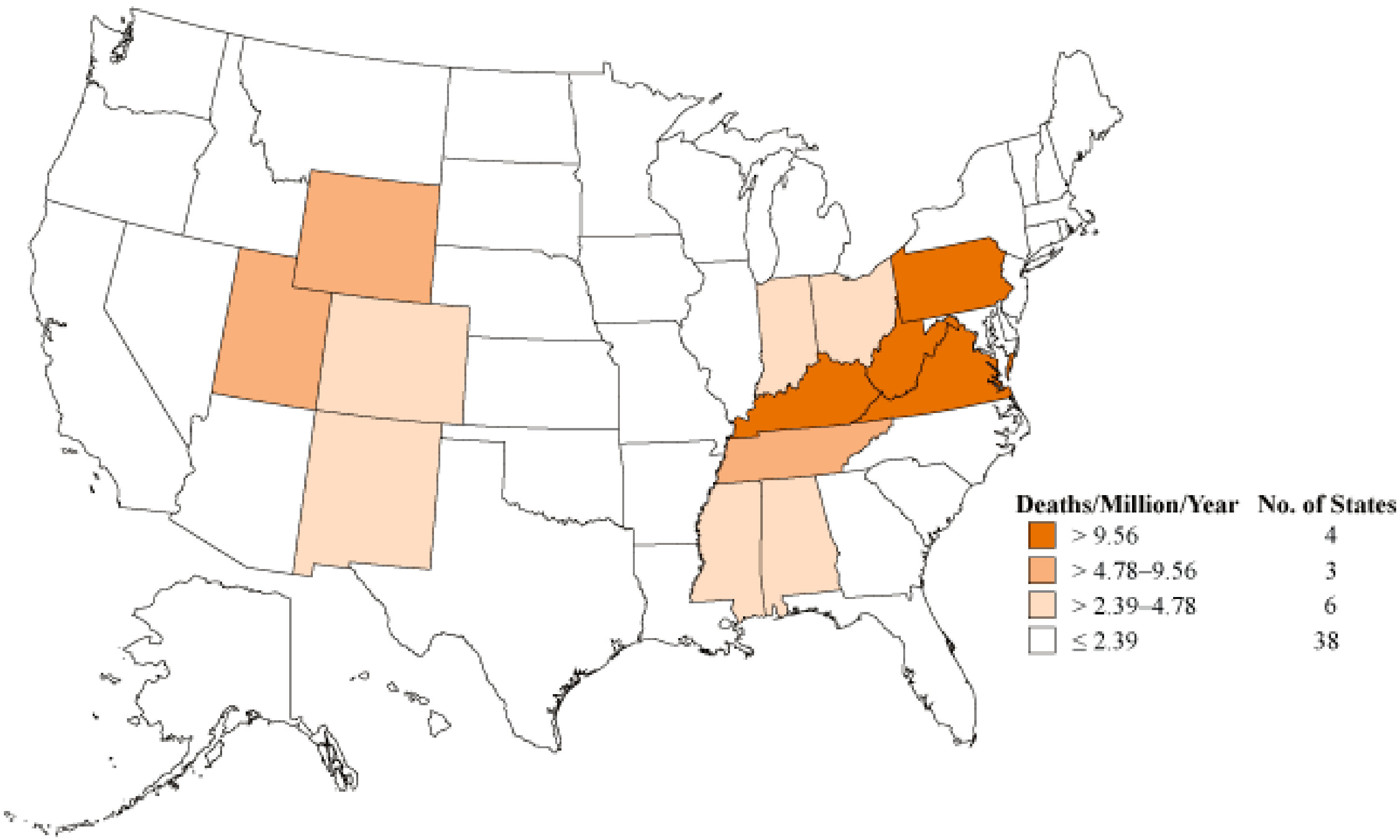


Deaths with CWP, age 15-44, national data



West Virginia

Mortality with CWP



CWP Mortality rates – highest counties in the nation

County	State	Age-Adjusted Rate	Crude Rate	Number of Deaths	% Female
Buchanan County	Virginia	1,351.1	1,172.4	262	0.4
McDowell County	West Virginia	863.1	1,046.1	232	0.4
Wyoming County	West Virginia	729.5	726.2	153	0.7
Raleigh County	West Virginia	619.5	701.6	458	0.0
Schuylkill County	Pennsylvania	570.6	871.5	1,089	0.1
Tazewell County	Virginia	566.1	642.4	236	0.0
Floyd County	Kentucky	488.1	440.8	153	0.0
Logan County	West Virginia	433.6	445.6	138	0.7
Mingo County	West Virginia	403.6	380.2	86	1.2
Fayette County	West Virginia	401.6	494.7	194	0.0
Lee County	Virginia	371.2	433.7	83	1.2
Wise County	Virginia	359.0	353.8	123	0.0
Harlan County	Kentucky	350.1	375.7	100	1.0

WV in 2008 – pneumoconiosis observed

- 1,517 coal miners examined in NIOSH program
  - Mean age = 47 years
  - Mean mining tenure = 22 years
  - 91 with any pneumoconiosis
  - 23 with PMF

WV in 2008 – pneumoconiosis expected (1)

- For 1517 miners with the **reported mean exposure of ~1 mg/m^3** expected numbers are:
  - 12 to 21 with any pneumoconiosis versus 91 observed, or ***<u>4 to 7</u>*** times as much as expected
  - 1 to 2 with PMF versus 23 observed, or ***<u>12 to 23</u>*** times as much as expected

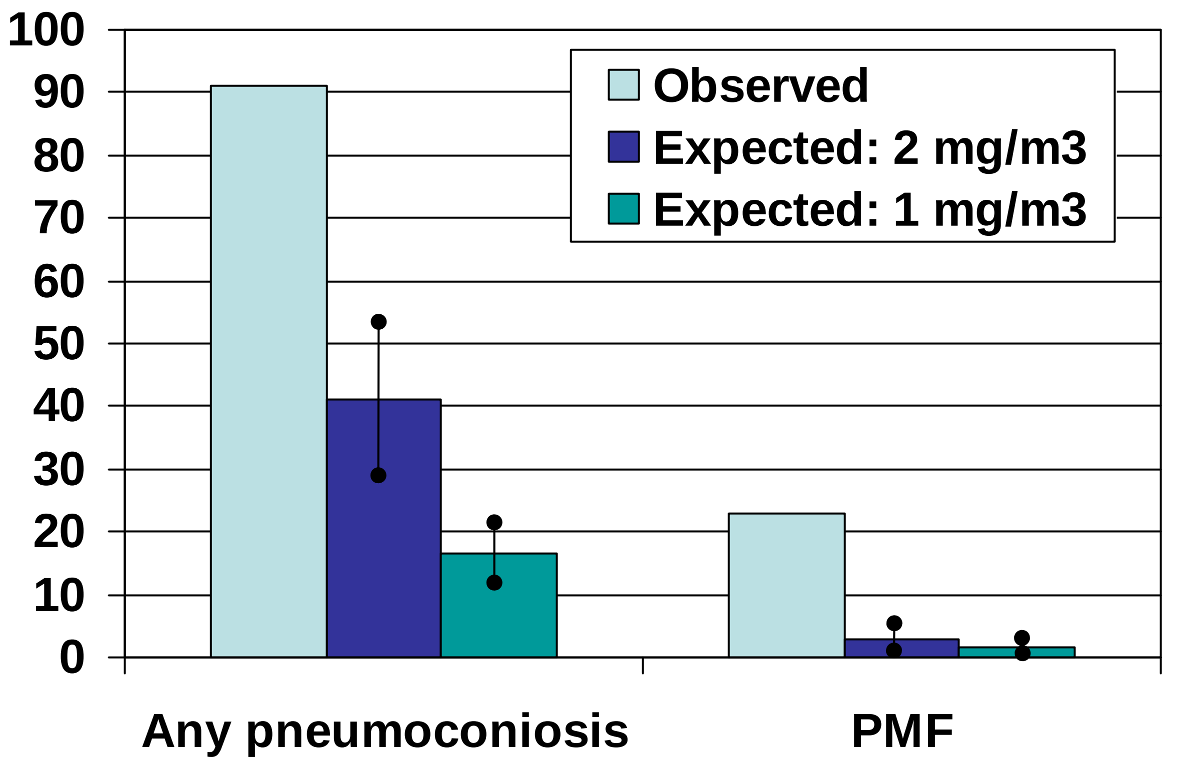
(reason for uncertainty in the expected numbers is that the predicted numbers depend on coal rank, and we don't know that for these miners)

WV in 2008 – pneumoconiosis expected (2)

- For 1517 miners with an exposure of **2 mg/m³ (MSHA PEL),** expected numbers are:
  - 28 to 54 with any pneumoconiosis versus 91 observed, or ***2 to 3*** times as much as expected
  - 1 to 5 with PMF versus 23 observed, or ***4 to 23*** times as much as expected

(reason for uncertainty in the expected numbers is that the predicted numbers depend on coal rank, and we don't know that for these miners)

WV in 2008 – expected (3)



Note: Expecteds averaged over coal ranks, range shown by

Reasons for increase

- Longer hours worked?
- Greater production?
- Inadequacies in dust control?
- Increased exposure to silica dust?
- Inadequate compliance method for silica?
- (Dust limits are too high)

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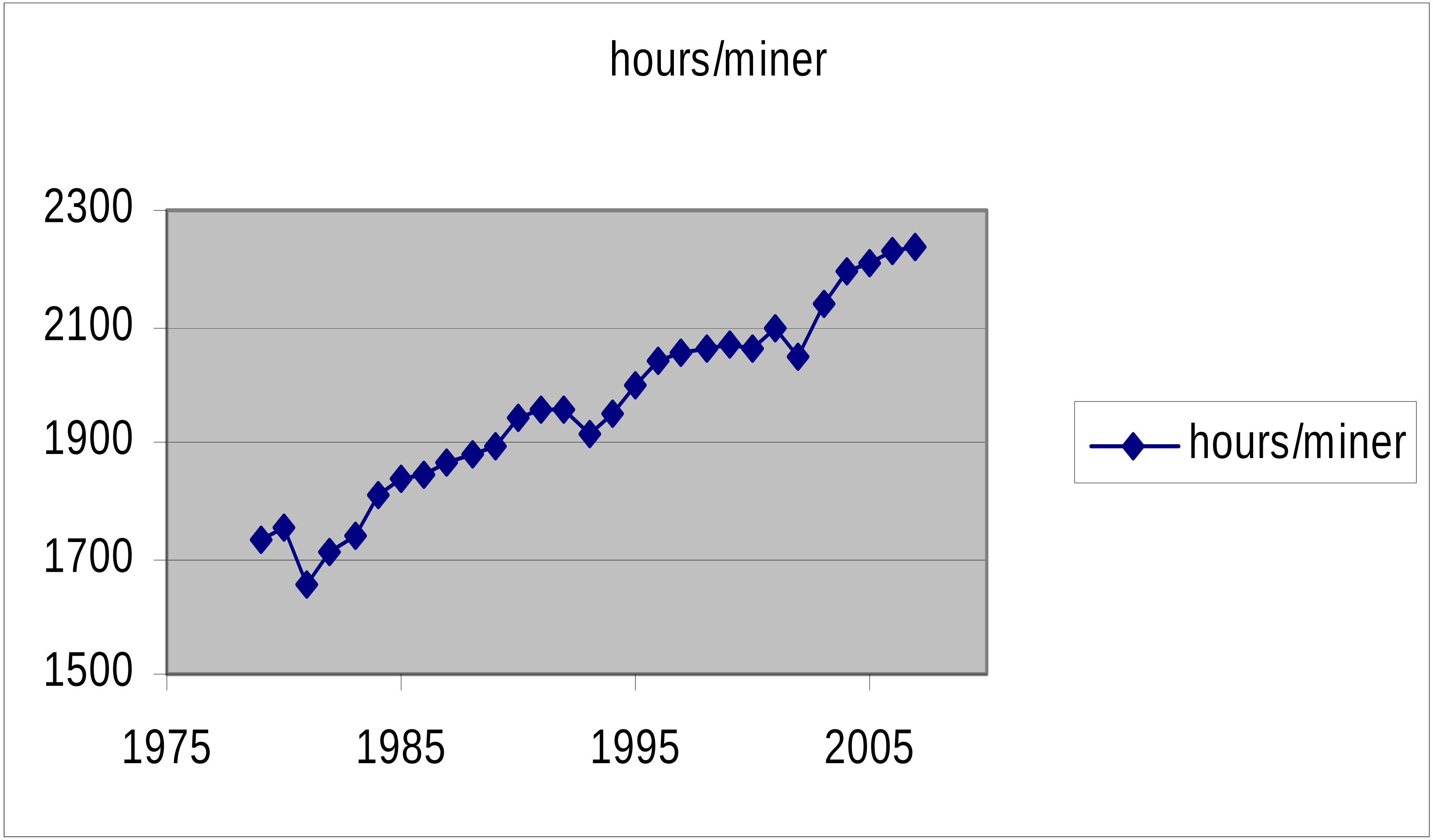
Hours worked/year



Data from MSHA website

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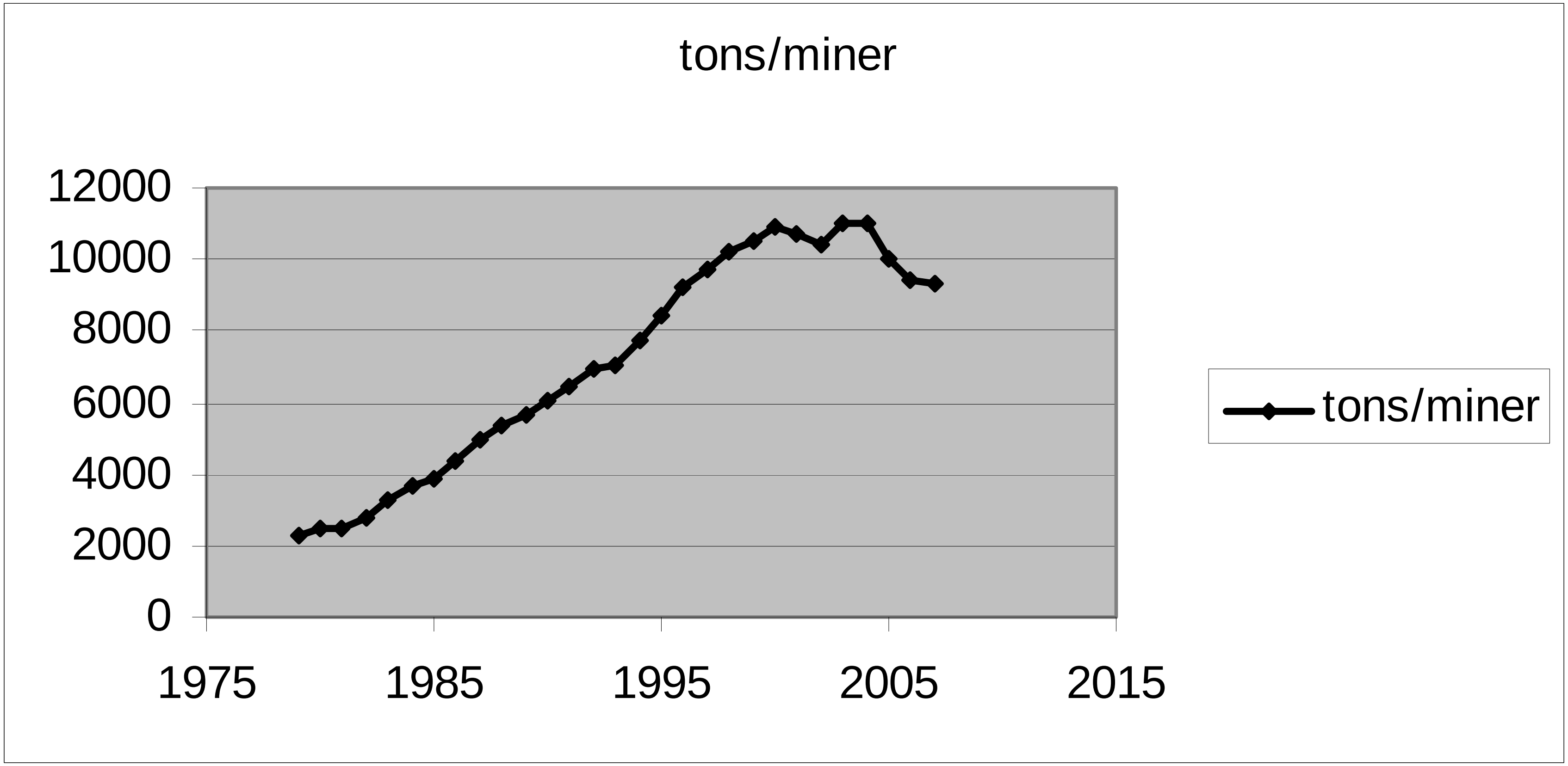
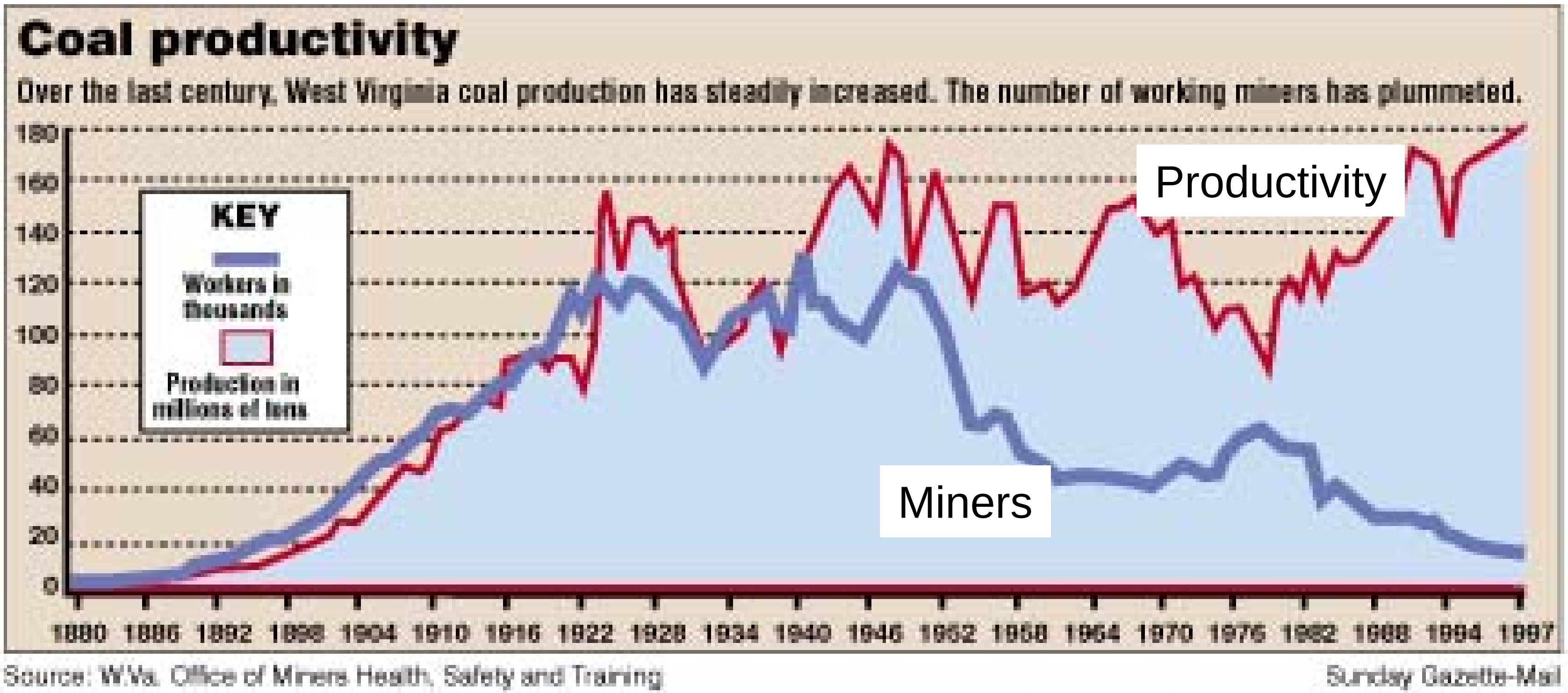
Tons per miner



Data from MSHA website

West Virginia coal employment and productivity



Reasons for increase

- Longer hours worked?
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- **Inadequacies in dust control?**
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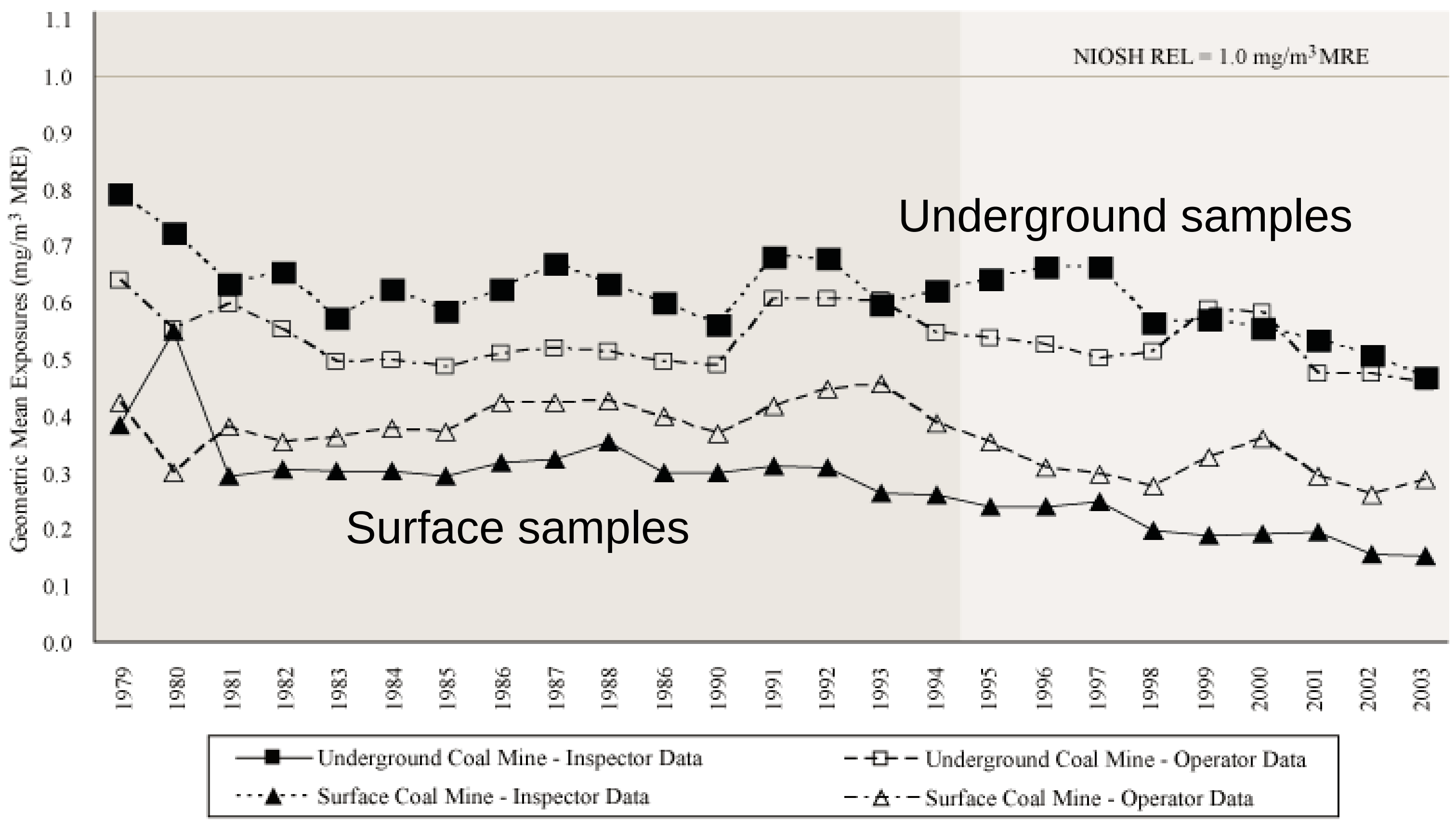
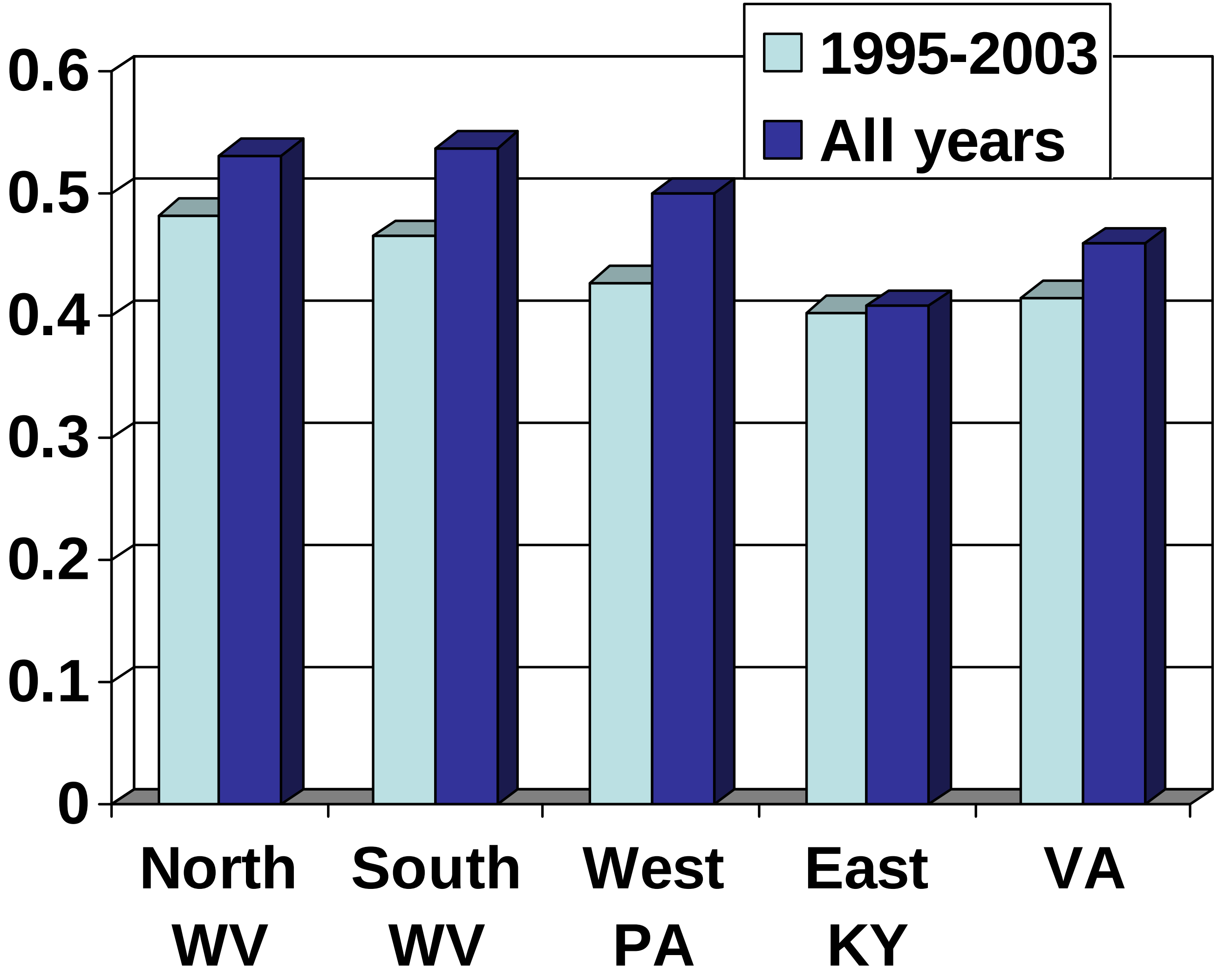
Reported dust levels are low



WV coal mine dust levels



American Journal of Industrial Medicine 6:427–440 (1984)

The Accuracy of Self-Reported Regulatory Data: The Case of Coal Mine Dust

Leslie I. Boden, PhD, and Morris Gold, AB

“Using two statistical approaches, data from three mining occupations in 54 large underground coal mines during 1976-1978 are examined for evidence of underreporting…Both approaches suggest widespread underreporting.”

The Fox Guarding the Chicken Coop:

Monitoring Exposure to Respirable Coal Mine Dust, 1969–2000

Following passage of the Coal Mine Health and Safety Act of 1969, underground coal mine operators were required to take air samples in order to monitor

James L. Weeks, ScD, CIH

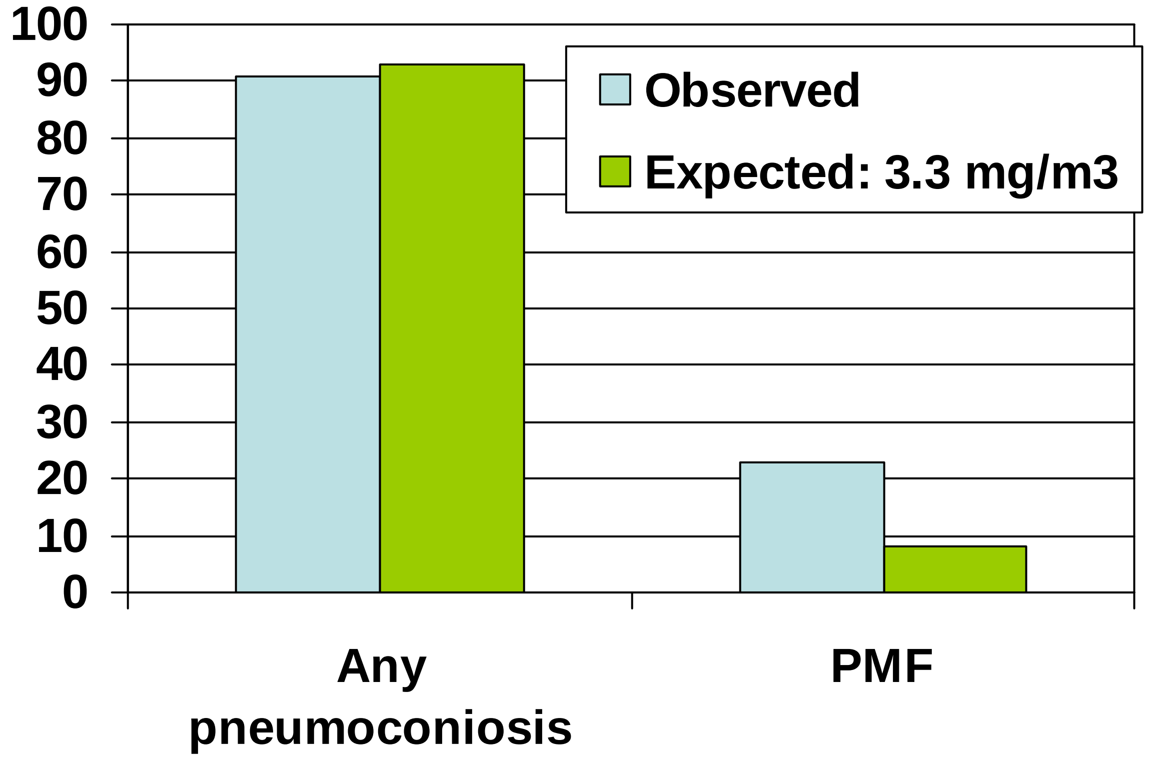
WHEN REGULAR MONITORING of underground miners' exposure to respirable dust began in 1970,

WVa. This catastrophe, the first mine disaster to have been televised, added significantly to the

One of the most controversial provisions was a plan to compen-

MSHA Special Inspection survey, 1991

WV in 2008 – pneumoconiosis expected (3)



Note: Expecteds averaged over coal ranks

Reasons for increase

- Longer hours worked?
- Greater production?
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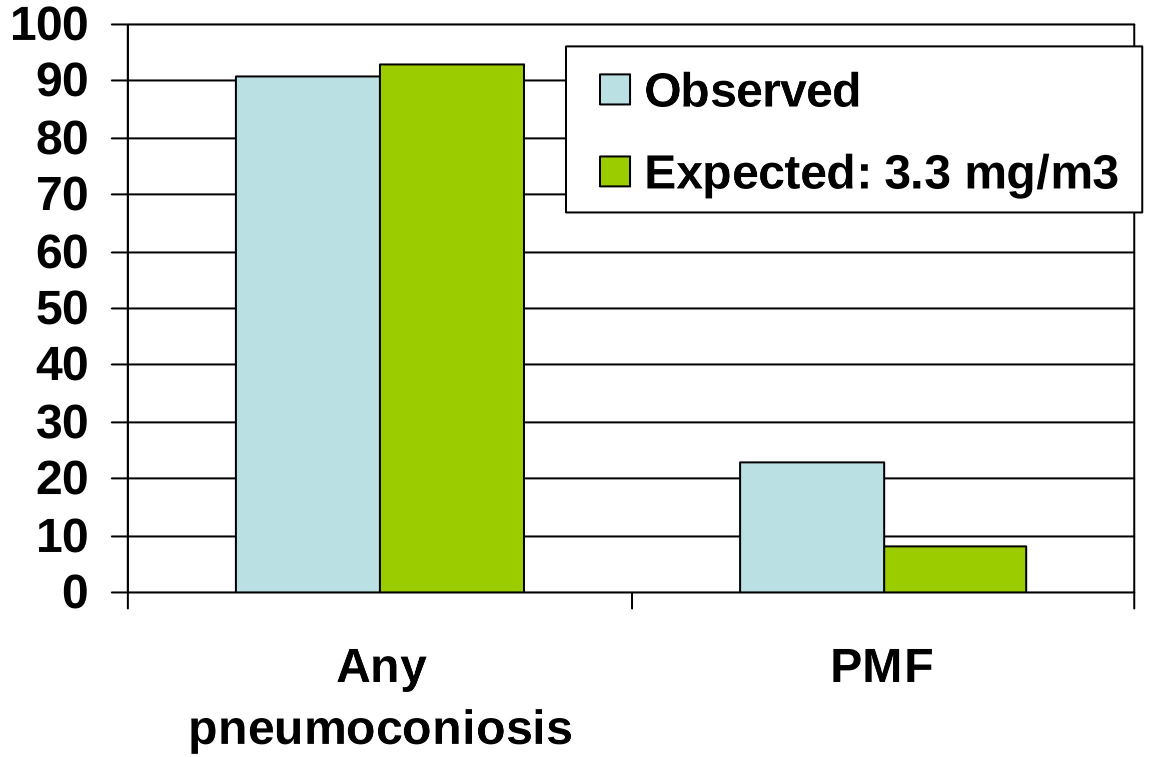
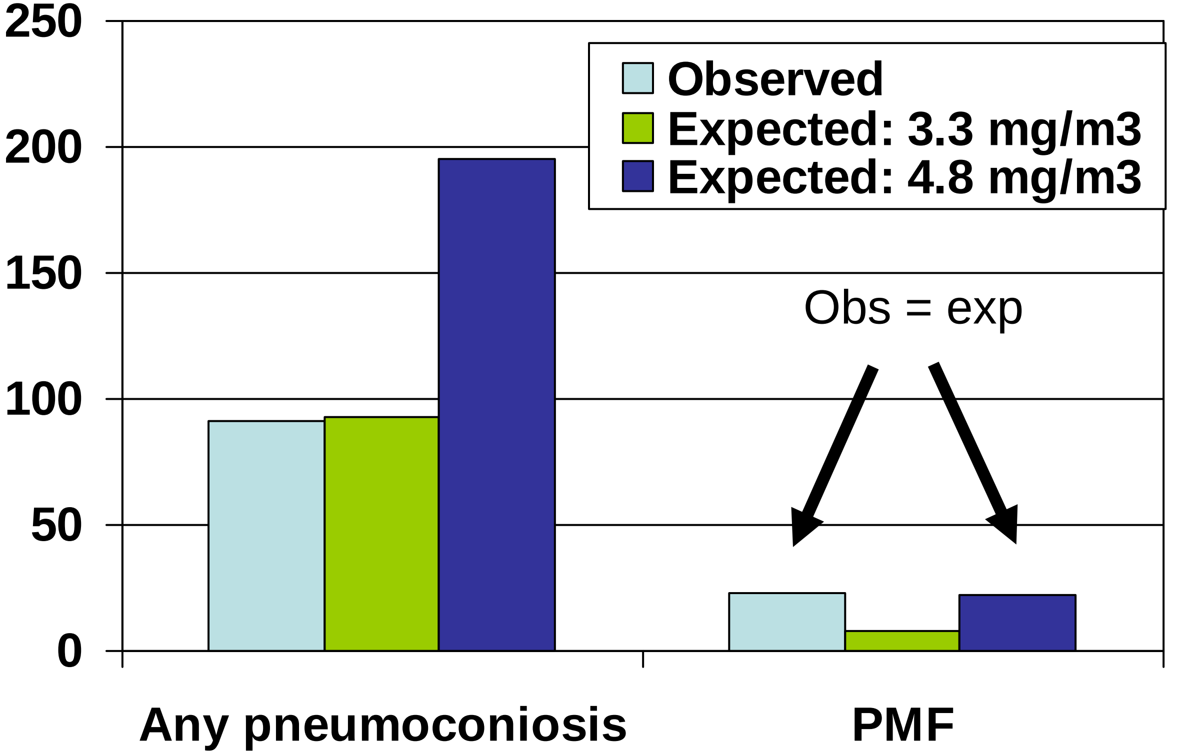
- Inadequate compliance method for silica?
- (Dust limit are too high)

WV in 2008 – pneumoconiosis expected (3)



Note: Expecteds averaged over coal ranks

WV in 2008 – pneumoconiosis expected (4)



Note: Expecteds averaged over coal ranks

Implication

- We are seeing more severe pneumoconiosis than we would expect in proportion to the overall levels of all pneumoconiosis
- This suggests another factor apart from excessive coal mine dust exposure
- Preliminary findings from our program support the interpretation that the increase is partly due to an increase in silicosis

Implication

Occupational Health

QUARTZ AND PNEUMOCONIOSIS IN COALMINERS

A. Seaton
J. Dodgson
J. A. Dick
M. Jacobsen

Institute of Occupational Medicine, Edinburgh and National Coal Board Radiological Centre, Wath-on-Dearne, near Rotherham, South Yorkshire

Summary In a routine survey of 623 miners in one colliery, 21 men, an unusually high number, showed radiological progression of simple pneumoconiosis in spite of generally low exposures to mixed coalmine dust. Comparison of the dust exposures of the 21 men with those of matched controls without pneumoconiosis showed highly significant differences in the proportion of quartz in the mixed dust to which they had been exposed. Quartz exposure may be an important factor in the development and rapid progression of coalworkers' pneumoconiosis. Some indication of the levels of quartz exposure which are likely to be hazardous is given.

Reasons for increase

- Longer hours worked?
- Greater production?
- Inadequacies in dust control?
- Increased exposure to silica dust?
- **Inadequate compliance method for silica?**
- (Dust limits are too high)

AM. IND. HYG. ASSOC. J. 52(3):107–112 (1991)

Regulatory Implications of Airborne Respirable Free Silica Variability in Underground Coal Mines

Jacqueline M. Villnave[a]
Morton Corn[b]
Marcie Francis[b]
Thomas A. Hall[c]

Deficiencies of the strategy include the same enforcement efforts regardless of compliance history, inappropriate treatment of data, and emphasis on short-term variability of silica content. These deficiencies result in inadequate enforcement in chronically dusty mines, "game playing" with optional samples, and an overall approach that does not focus on the long-term impact of silica exposure on lung health.

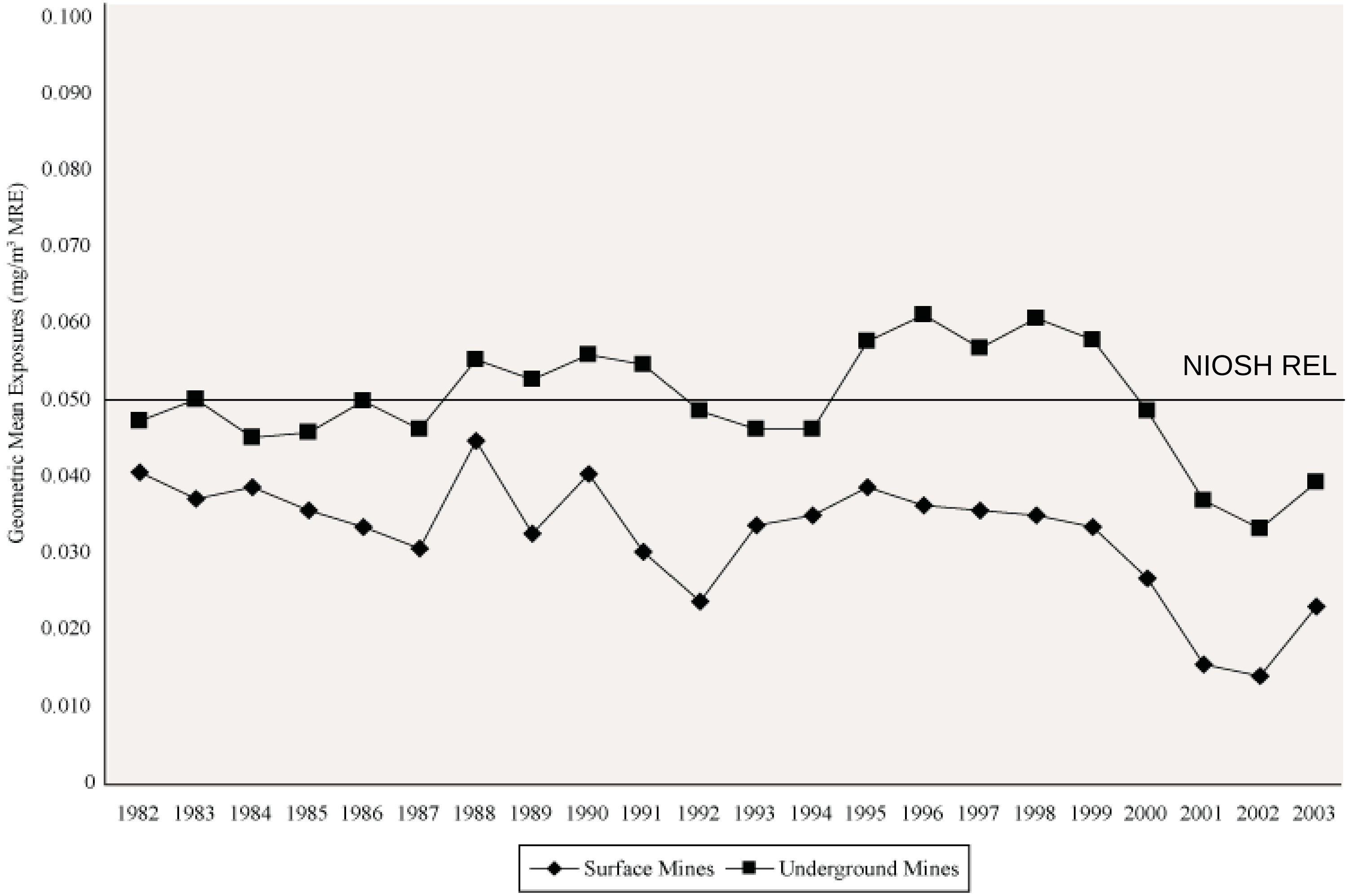
Am. Ind. Hyg. Assoc. J. 46(1):4-8 (1985)

A Critique of MSHA Procedures for Determination of Permissible Respirable Coal Mine Dust Containing Free Silica

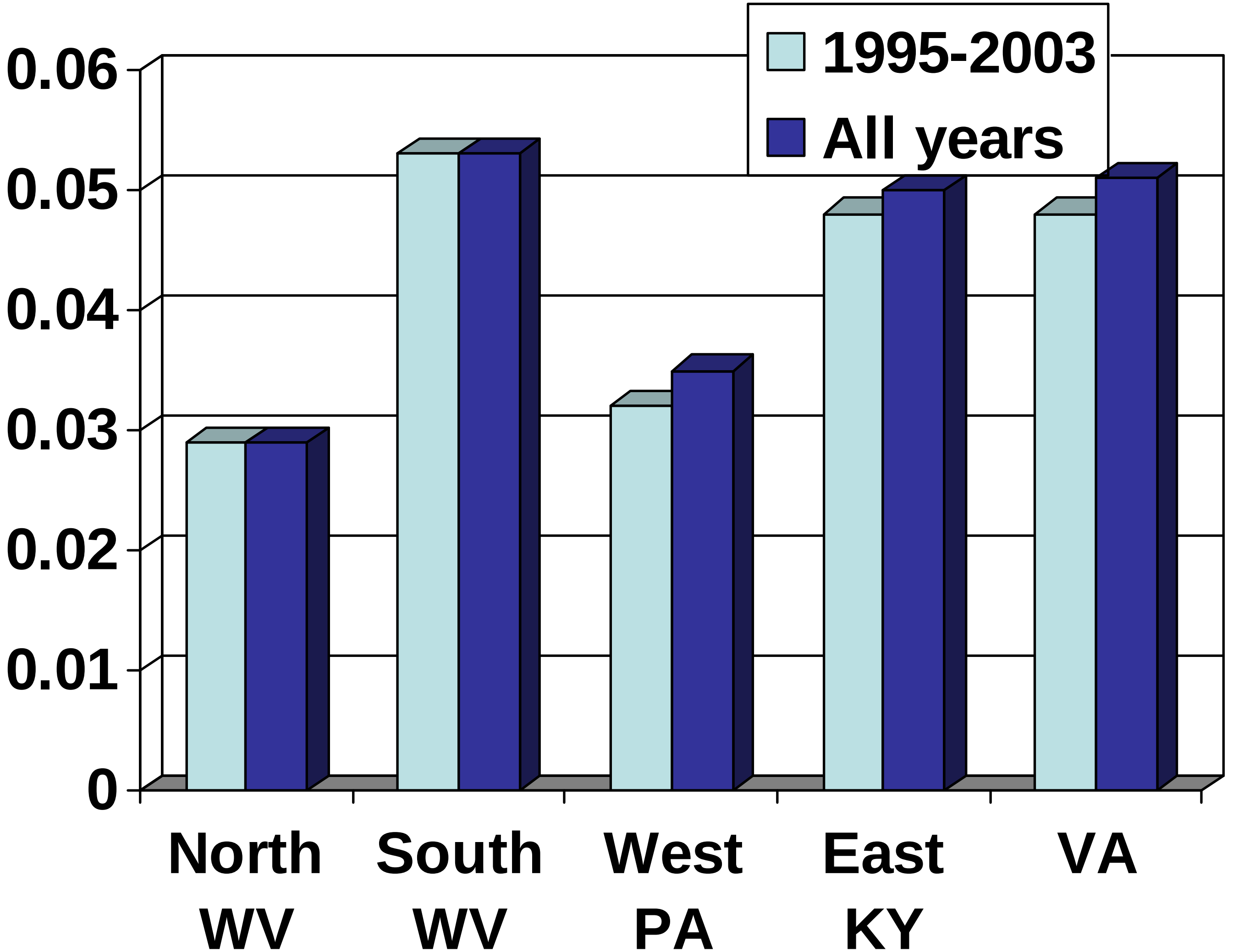
MORTON CORN, PATRICK BREYSSE, THOMAS HALL, GAO CHEN, TERENCE RISBY and DAVID L. SWIFT
Department of Environmental Health Sciences, The Johns Hopkins University, School of Hygiene and Public Health, Baltimore, MD 21205

"Although all of the analytical methods for crystalline free silica area sufficiently sensitive to be able to detect and quantitate free silica at environmentally significant concentrations, they are all plagued with similar difficulties."

National silica levels in coal mines



WV silica dust levels



Summary – What we know

- Prevalence of pneumoconiosis in miners with 20+ years of tenure x-rayed in the NIOSH monitoring program is rising
- Cases of severe disease being seen in young workers (<40 years old)
- Prevalence of pneumoconiosis far greater than expected from reported dust levels
- Dust limit should be reduced to 1 mg/m^3

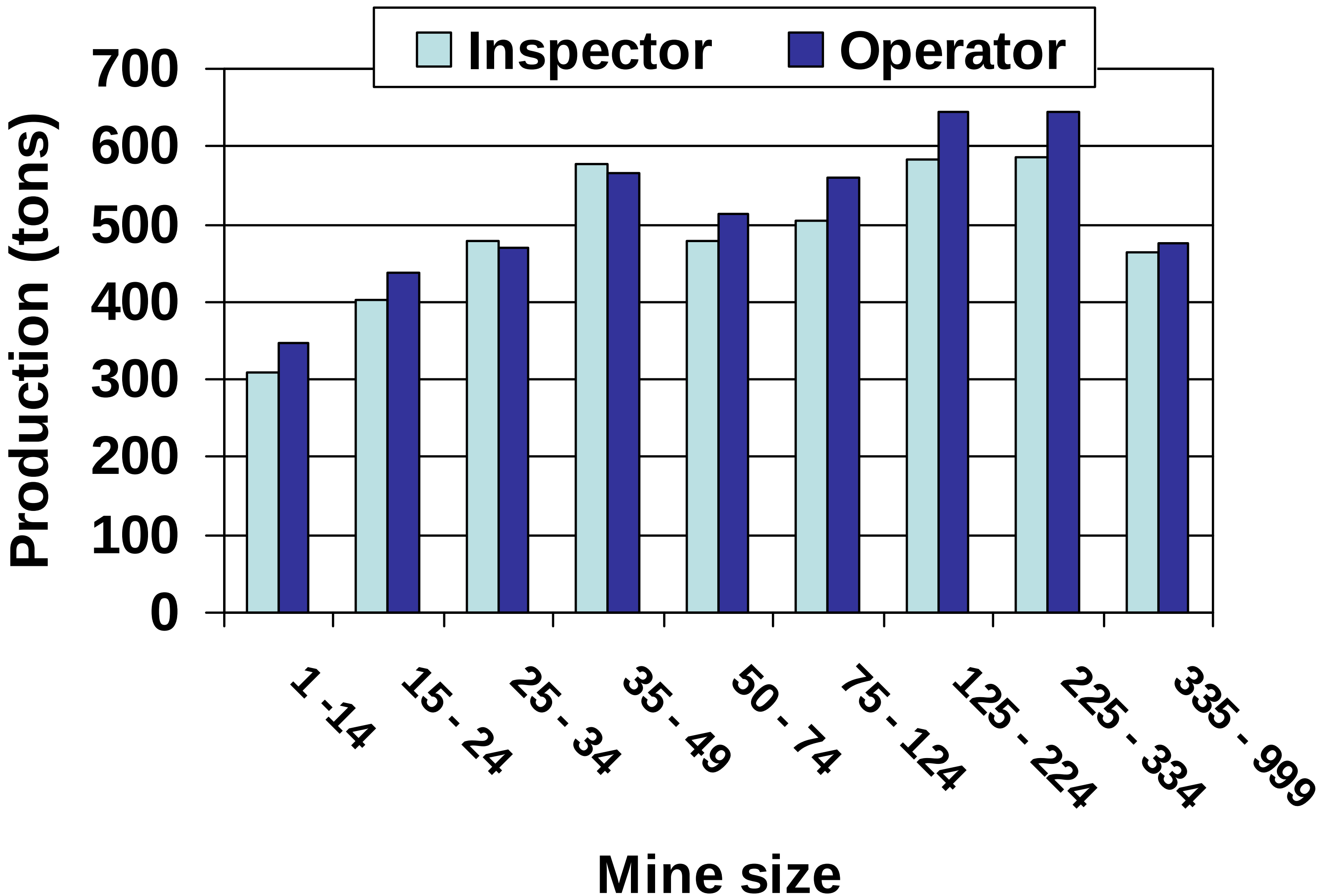
Summary – What we are unsure about

- Exact cause of increase in prevalence and severity is not known
- Multiple causes may be at work
  - Longer hours worked
  - Inadequate compliance coupled with increased productivity
  - Thin seam mining due to depletion of best coal reserves, leading to excess silica exposure and silicosis
  - Lack of knowledge/resources in small mines

Primary Solutions

- Require use of personal dust monitor (being tested by NIOSH)
- Beefed-up compliance
- State assistance in county extension work for smaller mines
- Adopt NIOSH RELs for coal mine dust and silica levels
- Change compliance assessment method for silica dust

MSHA Special Inspection survey, 1991



Effect of coal rank

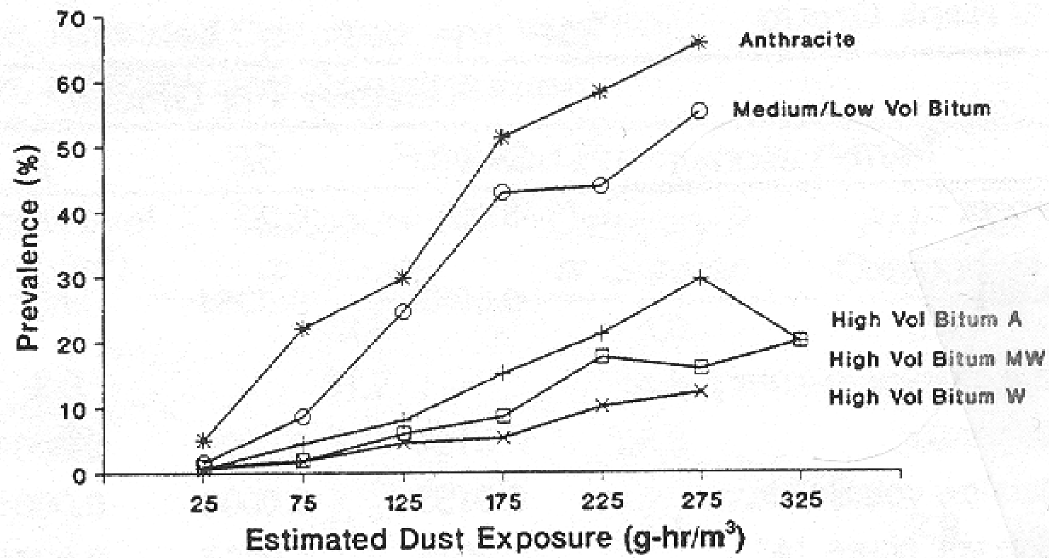


FIGURE 2. Exposure-response by coal rank group using prevalence of CWP Category 1 or greater and estimated dust exposure

Effect of coal rank

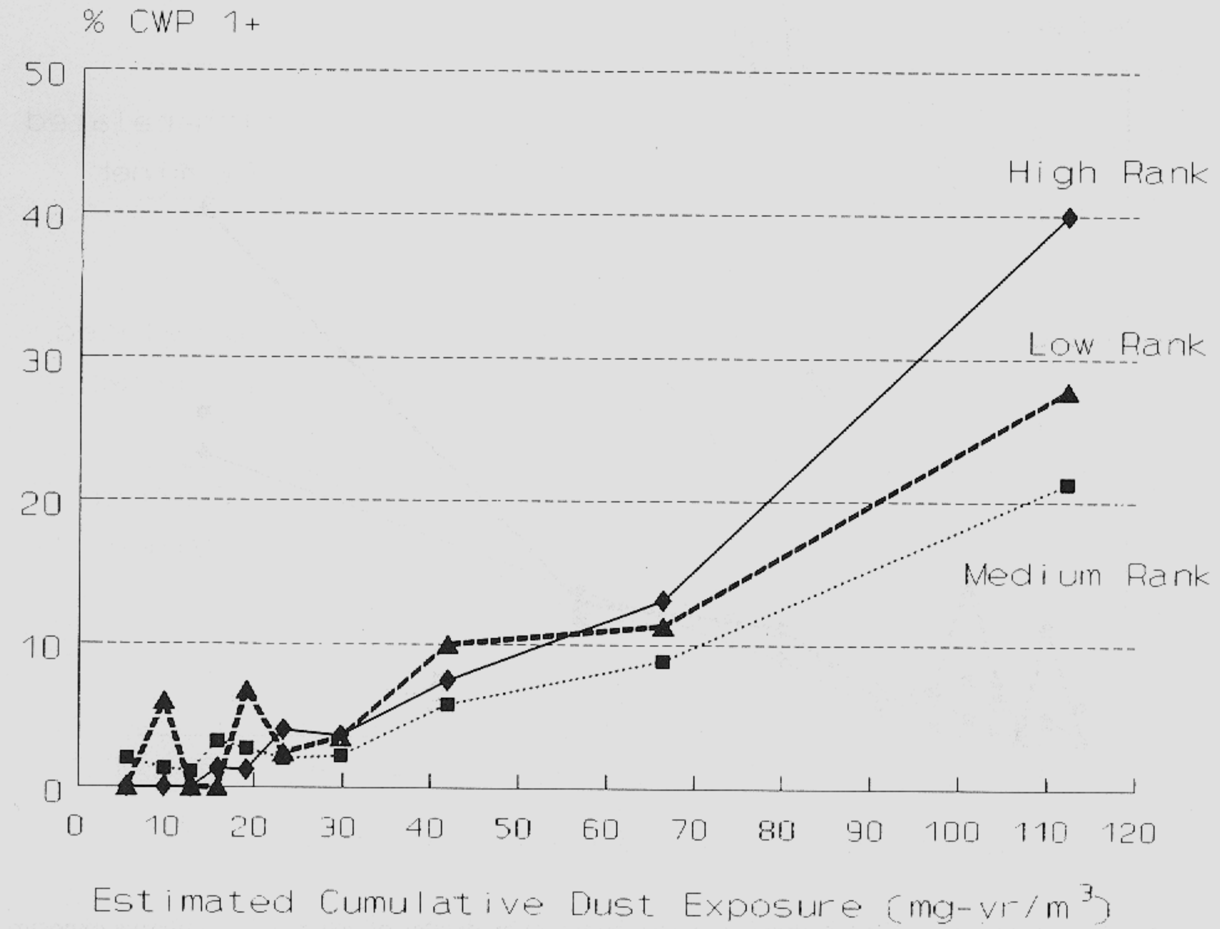
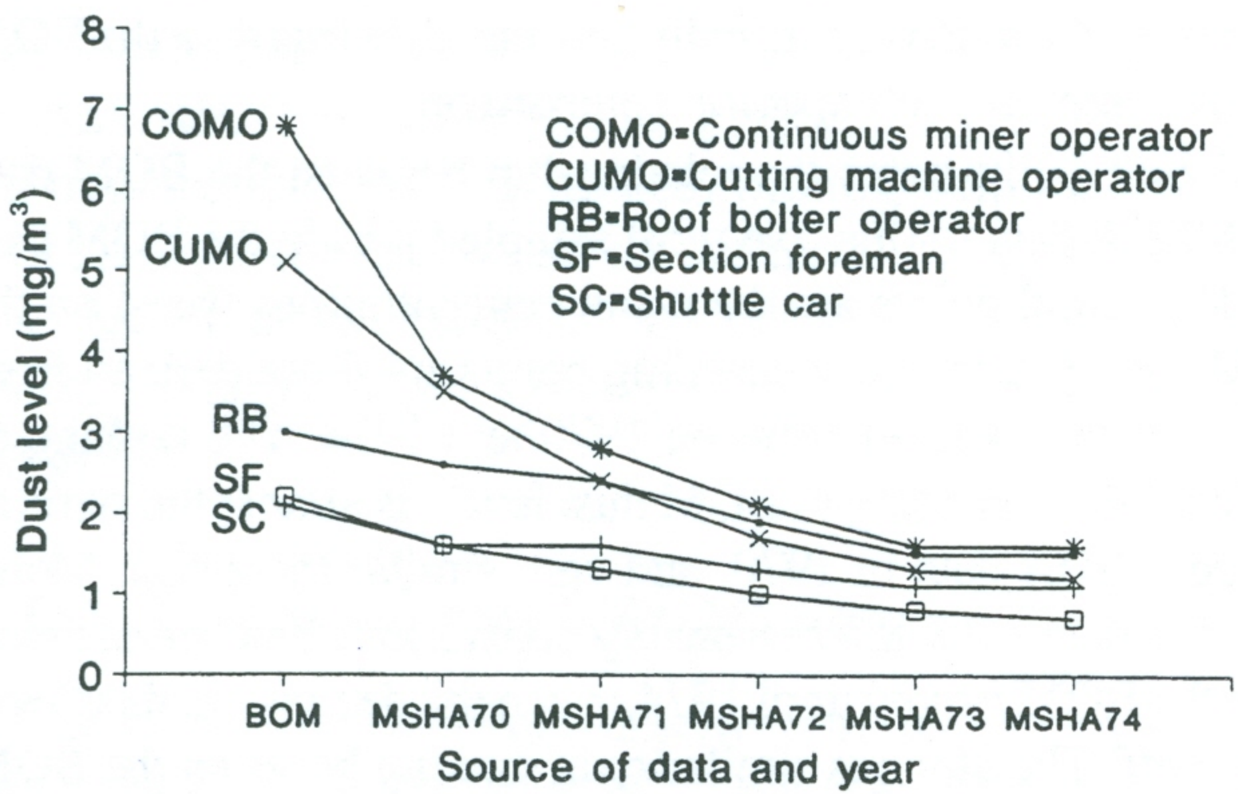


Fig. 3. Prevalences of CWP 1+ (median determinations) by deciles of estimated cumulative dust exposure and coal rank group.

Dust levels pre-1969 and in the early 1970s



WV silica levels in coal mines

MSHA Coal Mine District	All years		1982–1988			1989–1992			1993–2003		
	No. of Samples	(GM mg/m^3 MRE)	No. of Samples	(GM mg/m^3 MRE)	% > PEL*	No. of Samples	(GM mg/m^3 MRE)	% > PEL*	No. of Samples	(GM mg/m^3 MRE)	% > PEL*
District 1 (Anthracite coal mining regions in Pennsylvania)	**2,185**	**0.017**	**299**	**0.021**	**38.8**	**171**	**0.021**	**37.4**	**1,715**	**0.017**	**17.4**
District 2 (Bituminous coal mining regions in Pennsylvania)	**16,941**	**0.035**	**3,843**	**0.042**	**33.7**	**2,207**	**0.039**	**23.2**	**10,891**	**0.032**	**14.7**
District 3	**15,753**	**0.031**	**3,680**	**0.031**	**27.7**	**1,684**	**0.037**	**20.7**	**10,389**	**0.030**	**14.2**
Maryland	1,108	0.034	120	0.056	40.0	45	0.037	4.4	943	0.032	12.8
Ohio	5,356	0.034	1,871	0.038	32.2	719	0.036	21.7	2,766	0.031	14.6
Northern West Virginia	9,289	0.029	1,689	0.024	21.8	920	0.038	20.7	6,680	0.029	14.2
District 4 (Southern West Virginia)	**27,718**	**0.053**	**6,802**	**0.051**	**39.1**	**3,900**	**0.055**	**35.8**	**17,016**	**0.053**	**27.5**
District 5 (Virginia)	**17,991**	**0.051**	**4,264**	**0.056**	**44.3**	**2,795**	**0.057**	**36.6**	**10,932**	**0.048**	**22.0**
District 6 (Eastern Kentucky)	**21,839**	**0.050**	**2,706**	**0.050**	**39.8**	**2,529**	**0.066**	**41.2**	**16,604**	**0.048**	**24.3**

NIOSH REL = 0.05 mg/m^3

Dust levels in WV mines

MSHA Coal Mine District	All years		1979–1989			1990–1994			1995–2003			
	No. of Samples	GM (mg/m^3)	No. of Samples	GM (mg/m^3)	% > PEL	No. of Samples	GM (mg/m^3)	% > PEL	No. of Samples	GM (mg/m^3)	% > PEL	% > REL
District 1 (Anthracite coal mining regions in Pennsylvania)	**47,537**	**0.202**	**22,699**	**0.218**	**2.7**	**9,269**	**0.184**	**2.4**	**15,569**	**0.191**	**2.6**	**9.6**
District 2 (Bituminous coal mining regions in Pennsylvania)	**315,887**	**0.499**	**208,477**	**0.514**	**9.7**	**39,729**	**0.559**	**9.3**	**67,681**	**0.427**	**5.1**	**22.3**
District 3	**278,414**	**0.553**	**183,654**	**0.591**	**12.7**	**37,586**	**0.532**	**7.5**	**57,174**	**0.458**	**5.2**	**24.3**
Maryland	11,559	0.589	5,655	0.677	13.1	1,496	0.617	6.8	4,408	0.485	5.0	30.0
Ohio	92,171	0.592	66,363	0.672	16.3	9,714	0.476	5.8	16,094	0.401	4.9	23.6
Northern West Virginia	174,684	0.531	111,636	0.543	10.5	26,376	0.550	8.1	36,672	0.482	5.3	23.9
District 4 (Southern West Virginia)	**505,675**	**0.537**	**306,684**	**0.571**	**14.6**	**76,841**	**0.526**	**10.4**	**122,150**	**0.465**	**7.8**	**25.0**
District 5 (Virginia)	**319,938**	**0.459**	**189,744**	**0.464**	**9.3**	**54,490**	**0.505**	**8.1**	**75,704**	**0.415**	**4.8**	**18.8**
District 6 (Eastern Kentucky)	**317,849**	**0.408**	**154,077**	**0.392**	**7.0**	**57,013**	**0.464**	**8.1**	**106,759**	**0.403**	**5.4**	**19.5**