Epidemiological Data on US Coal Miners' Pneumoconiosis, 1960 to 1988

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ABSTRACT

Objectives. Statistics on prevalence of pneumoconiosis among working underground coal miners based on epidemiologic data collected between 1960 and 1988 are presented. The main intent was to examine the time-related trend in prevalence, particularly after 1969, when substantially lower dust levels were mandated by federal act.

Methods. Data from studies undertaken between 1960 and 1968 were collected and compared. Information for the period 1969 to 1988 was extracted from a large ongoing national epidemiologic study. Tenure-specific prevalence rates and summary statistics derived from the latter data for four consecutive time intervals within the 19-year period were calculated and compared.

Results. The results indicate a reduction in pneumoconiosis over time. The trend is similar to that seen in a large radiologic surveillance program of underground miners operated concurrently.

Conclusions. Although such factors as x-ray reader variation, changes in x-ray standards, and worker self-selection for examination may have influenced the findings to some extent, adjusted summary rates reveal a reduction in prevalence concurrent with reductions in coal mine dust levels mandated by federal act in 1969. (*Am J Public Health.* 1992; 82:964–970)

Introduction

The National Institute for Occupational Safety and Health (NIOSH) receives frequent requests for information on the prevalence of coal workers' pneumoconiosis (CWP), but no current and comprehensive statistics are available in a convenient format. Two reports have been compiled to fill this gap. The first, this paper, concerns the findings from epidemiological studies undertaken from 1960 to 1988, including the National Study of Coal Workers' Pneumoconiosis (NSCWP), a large nationwide epidemiological study managed by NIOSH. The second[1] deals with information from the Coal Workers' X-ray Surveillance Program (CWXSP) from 1970 to 1986.

Among the provisions of the 1969 Federal Coal Mine Health and Safety Act[2] was a directive that a research program be set up to inquire into the respiratory health of US coal miners. The NSCWP, begun in 1969 and still in progress, was the response to this mandate. Based on mines selected from all the major coalfields, it is the largest and longest-running epidemiological study of coal miners in the United States. Many of the mines were included in some earlier medical[3] and environmental[4] investigations. Medical examinations were undertaken at these NSCWP mines up to four times between 1970 and 1988.

The NSCWP was designed to estimate levels of lung disease in underground coal miners, and to study the relationship between disease and the level and constituents of dust exposure. Results from the study have shed a great deal of light on CWP in US coal miners,[5–10] as well as on other lung diseases.[11–13] To date, however, the CWP reports based on NSCWP data have been tailored to suit a variety of specific inquiries, and their resulting lack of uniformity in format makes comparison among them difficult. Furthermore, careful review of these reports reveals apparent inconsistencies between the prevalences of CWP published at different times—notably, between those published at the start of the study and those disseminated later. The objective of the present paper is to present all the NSCWP-generated CWP prevalence estimates, along with those of preceding US studies, in a unified manner, and to review and explain the differences and inconsistencies.

Coal Workers' Pneumoconiosis. CWP is almost always identified in living coal miners by examination of the chest radiograph. Coal mine dust deposits in the lung give rise to radiographic opacities. Small (less than 1 cm diameter) opacities are classified into four major categories (0, 1, 2, and 3) by reference to standard films representing levels of profusion. The current reference is the 1980 International Labour Office (ILO) classification system.[14] Small opacities are also classified according to shape (rounded or irregular). The actual approach to differentiating between small rounded and small irregular opacities and to determining profusion has differed over the years (see below). This report concentrates on small rounded opacities because that type has been conventionally associated with coal mine dust exposure.[15]

Simple CWP is manifested by small opacities on the chest radiograph. It is dis-

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tinguished from complicated CWP, also known as progressive massive fibrosis (PMF), a more advanced form of CWP manifested by large radiographic opacities (at least 1 cm in diameter) on the chest radiograph.

Historical Information. Prior to the 1969 promulgation of federal limits on airborne respirable dust concentration in US underground coal mines, respirable dust levels substantially exceeded the current federal limit of 2 mg/m^3. For example, Jacobson[4] showed that average dust concentrations for certain miners working at the coal face were close to 6 mg/m^3, and that the mean concentrations for most other underground jobs were above 2 mg/m^3.

Shown in Table 1 are summary results on prevalence of category 1 or greater CWP derived from eight reports published between 1961 and 1970.[3,16-22] Eleven regions were involved, ranging from the anthracite coalfield of Pennsylvania to southern mines located in Alabama and to western mines in Utah. This review extends that of Morgan.[23] With the exceptions noted in the footnotes to the table, all the information concerns working coal miners and is based on the 1959 ILO classification.[24] For these tabulations, category Z opacities (suspicious markings) were classified with those in category 0.

Table 1 arranges the studies according to rank of coal (higher coal rank implies an older coal of higher percentage carbon), there being evidence that CWP incidence varies with coal rank.[5] The regions considered were high rank (anthracite), medium-high rank (low volatile bituminous), medium rank (mainly high volatile "A" bituminous), and medium-low rank (mainly high volatile types "B" and "C" bituminous). The results confirm the previously reported association between CWP prevalence and coal rank. Mean mining tenure and age were similar across coal rank groups and therefore were unlikely to have been responsible for the observed coal rank trend. A fair amount of interstudy variation within coal rank groups is seen, which may have resulted from the use of different x-ray standards and readers. Varying rates of worker participation and differences in dust exposure (data not available) may also have contributed to the variation.

Tenure-specific prevalences from these studies, where available, are plotted in Figure 1. In every study, prevalence of small rounded opacities increased with increasing tenure. Agreement is quite good for those studies from the lower rank regions.

Information on more advanced profusions of small opacities was available from only four studies, and findings for category 2 or greater small opacities varied from 22% in working miners in the high rank region,[16] to 21% and 33% in medium-high rank coal miners,[18,19] to 7% in medium rank miners.[22] Large opacity prevalence also varied fairly consistently with

TABLE 1—Prevalence Rates of Coal Workers' Pneumoconiosis (Category 1 or Greater) for Some US Studies Undertaken between 1961 and 1970, in Order of Coal Rank

Study (by Probable Coal Rank)	Prevalence of CWP (Category 1 or Greater)	PMF	Mean Age, y	Mean Tenure, y: Mine	Mean Tenure, y: UG	Comments (See Below)
High rank						
A. Eastern Pennsylvania[16]	22	9.6	55	26	...	1
B. Eastern Pennsylvania[17]	34	...	45	...	22	1, 2
Medium-high rank						
C. Central Pennsylvania[18]	25	8.3	47	27	...	1
D. Southern West Virginia[19]	46	7.2	52	...	25	1, 3
E. Southern West Virginia[20]	14	5.4	44	...	...	4
Medium rank						
F. Appalachia[3]	10	3.0	47	...	22	5
G. Eastern West Virginia[20]	6	1.1	43	...	...	4
H. Northern West Virginia[21]	7	0.9	48	...	19	1, 3
I. Western Pennsylvania[22]	9	3.7	47	26	...	1
Medium-low rank						
J. Illinois/Indiana[3]	6	1.5	48	...	20	5
K. Utah[3]	4	0.7	51	...	20	5

Notes. PMF = progressive massive fibrosis; Mine = all work in coal mining; UG = work underground.
1. The 1959 ILO classification[24] was used.
2. Exact figure for average age is not given; figure given here has been estimated from age distribution data.
3. Group contains both current and ex-miners, and could not be subdivided.
4. Radiographic classification is not stated but is probably the ILO 1959 scheme,[24] given that the study was undertaken from 1963 to 1964.
5. The classification used is not stated explicitly. The reading sheet shown in the report looks very similar to that of the ILO 1968 classification,[25] but Morgan[23] states that the ILO 1959 classification system was used.

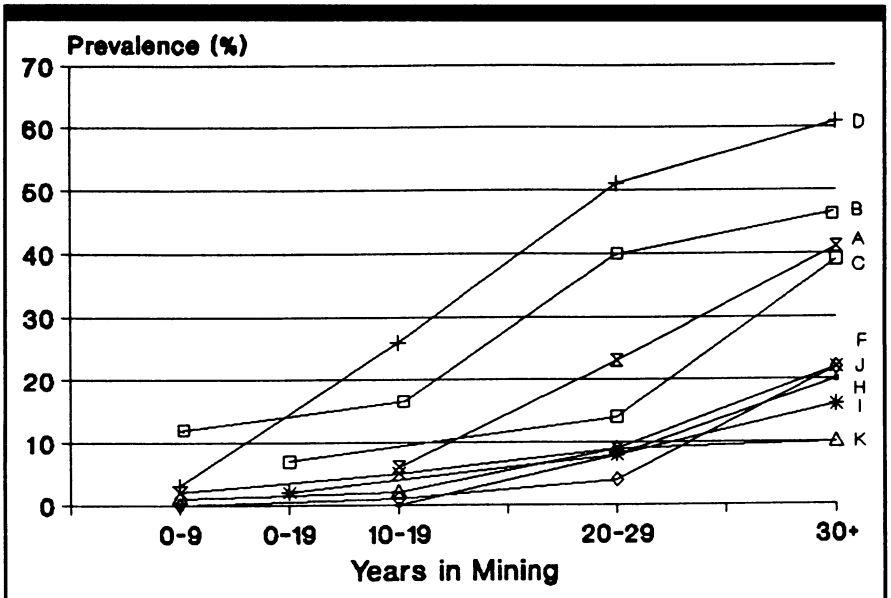

FIGURE 1—Prevalence of category 1 or greater small rounded opacities by tenure in mining for studies of underground US coal miners published between 1961 and 1970. (See Table 1 for the studies corresponding to the letters.)

coal rank, from about 10% in the high rank region[16] to about 1% in the medium-low rank region[3] (Table 1). Prevalences of large opacities were markedly higher in workers who were close to retirement age, with 19%, 18%, and 9% prevalences being reported for high, medium-high, and medium rank regions of Pennsylvania, respectively.[16,18,22]

NSCWP Methods

Survey Information

The NSCWP has been conducted in rounds of medical surveys. Round 1 examinations were conducted from 1969 to 1971, round 2 from 1972 to 1975, round 3 from 1977 to 1981, and round 4 from 1985 to 1988. The procedure in each of the first three rounds was to examine the miners at the mine site, either before or after their work shift, using a mobile x-ray trailer. Forty mines have been visited at one time or another over the course of the study. Thirty-one mines were visited at round 1. The principal criteria at round 1 for the selection of mines were (1) an expected life of the mine of at least 10 years, (2) a work force of at least 100 miners, (3) a geographic and geologic spread, and (4) accessibility for the field examination trailer. Owing to unexpected mine closings, nine other mines were substituted in round 2 following the same selection criteria.

Rounds 1 to 3 were a series of cross-sectional studies at virtually the same group of mines. Round 4 was organized very differently, being a follow-up of selected miners from the first two rounds. As a consequence, most of the round 4 examinations were not undertaken at the original mine sites but comprised what were termed "community surveys." Based on residence addresses, suitable clusters of miners and ex-miners were identified from the follow-up cohort. The mobile examination trailer was set up at a central location in each of 22 communities where clusters occurred, and individual contacts were made to encourage miners in the follow-up cohort to participate in the examination. In addition, mine surveys were held at three of the original mines; more were not possible because many of the original mines had closed or were nonoperational owing to the coal mining recession that occurred in the mid-1980s.

Low participation rates have been a problem with some rounds of the NSCWP. Although participation was very good at round 1 (accounting for 90% of those eligible at time of examination), the next two surveys were marked by a substantial decline in participation to 75% at round 2 and to 52% at round 3. The change in study design and survey strategy in round 4 led to an improvement in participation, accounting for 70% of those selected at the community studies and better rates at the mine site surveys.

X-ray Readers, X-ray Classifications, and Associated Methods

Apart from a switch to rare earth screens in 1985, the x-ray equipment and methods have changed little over the course of the NSCWP. Throughout the study, three x-ray readings were obtained for each chest radiograph. To date, resources have not been available to reread all the films using the same readers, protocol, and classification. Therefore, the information presented here is based on the original readings made at each round of the NSCWP.

The round 1 films were classified using the Union Internationale Contre le Cancer (UICC)/Cincinnati (U/C) classification system.[26] Of the three interpreters employed, only two specifically classified small rounded opacities (readers 1 and 2). These were both expert readers, who had collaborated with others in developing the UICC/Cincinnati classification system.[26] Later examination of their readings revealed, however, that reader 1 found improbably high levels of abnormality. His results give rise to prevalences that deviate substantially from every other source, including prior studies, other NSCWP surveys, concurrent surveillance program data,[1] and readings from a group of British interpreters.[27] Because of this discrepancy, his results have not been included in this analysis. Instead, the round 1 data presented here are those of the single remaining reader who classified small rounded opacities (reader 2); this interpreter's findings were much more consistent with those of the other sources noted above. (The readings of reader 1 were included in an earlier analysis,[5] which thereby reported a considerably greater prevalence of CWP than that given here.)

The 1971 ILO U/C classification system[28] was adopted for round 2. Readers 2 and 3 from round 1, along with seven other B readers (readers who have taken and passed a NIOSH-administered test of competency in reading for the pneumoconioses),[29] classified radiographs in the second round. All cases included in this analysis were based on median determinations of three readings of small rounded opacities.

The round 3 results presented here were also based on median determinations of small rounded opacities, this time made by three B readers using the 1971 classification. None of the three readers had participated in the earlier rounds.

For round 4, each film was independently read by three B readers using the 1980 ILO classification system.[14] Because the 1980 system does not permit profusions of small rounded and small irregular opacities to be classified separately, small rounded opacity profusion was put equal to the overall profusion score if rounded opacities were reported to predominate. However, if irregular opacities were said to be more common, the small rounded opacity profusion was set to 0. This approach probably tends to exaggerate the rounded profusion category when the primary type is rounded, and to underestimate the rounded profusion category when irregular opacities predominate.

To select readers for round 4, readings of all B readers who had read films for round 4 of the CWXSP were tabulated, and the readers were ranked according to amount of abnormality detected. Three readers lying in the midrange were then selected. None of these readers had participated in earlier rounds of the NSCWP.

In addition to small rounded opacities, this report also presents information on progressive massive fibrosis. The data were derived from reader 2 at round 1 and from medians of three readings at each of the subsequent rounds. Some summary statistics are also given on small combined opacity prevalences obtained similarly from reader 2 at round 1 and from medians elsewhere.

Throughout the NSCWP, occupational histories were obtained from the miners using a standardized questionnaire that varied little over the four rounds.

The tabulations that follow are based on all complete sets of data (readable x-rays and available tenure information) from each round, with the exception of round 4. For round 4, ex-miners who said they had left work because of health reasons were not included in order to make round 4 results more compatible with those from the earlier rounds. In general, these ex-miners had more abnormality than the others. However, laid-off miners and ex-miners who had taken other jobs were included with the current miners in the round 4 tabulations. The great major-

ity of these miners had left mining within a year or two before the medical survey.

NSCWP Results

Distribution of Examined Miners by Geologic Region

Table 2 shows how the data for those cases with valid x-ray readings were distributed across four geologic regions. A slight temporal movement from high to low rank coal areas is apparent. This generally reflects the pattern of mine closings that has occurred over the past two decades, particularly in the high rank region. Note, however, that the percentages of miners in the medium and medium-low rank regions remain almost constant over the four rounds.

TABLE 2—Miner Location by Round and Coal Rank Region as Defined by the National Study of Coal Workers' Pneumoconiosis

Region	Round 1[a] Miners	Round 2[a] Miners	Round 3[a] Miners	Round 4[a] Miners
High rank, %	6	3	0	0
Medium-high rank, %	15	14	19	17
Medium rank, %	55	58	55	51
Medium-low rank,%	25	25	27	32
Number of participants	9078	9347[b]	5275	3534
Number of x-ray readings	9034	8385[b]	5131	3451

[a]Percentages were based on the number of x-ray readings.
[b]Films for miners at two mines at round 2 were read by one reader only, leading to a larger difference between the numbers of participants and readings than exist for the other three rounds.

Distribution of Examined Miners by Tenure

The tenure distribution of coal miners has changed considerably over time owing to economic activity and other factors (Table 3). Prior to 1973, the coal mining work force was quite elderly, as the industry had been undergoing a long-term decline. Over the next few years, many of the older and longer-tenured miners left mining and were replaced by younger workers. More importantly, a large number of new miners were hired in the wake of the energy crisis–related mining expansion that took place in the mid-1970s. Since then, the mean age of the work force has been gradually rising.

Also included in Table 3 is a tenure distribution projected for the underground coal mining work force for 1986. This was derived from data collected from a mail survey of coal mine operators undertaken by the Bureau of Mines.[30] The data, which apply to both underground miners and surface workers at underground facilities in the bituminous and anthracite regions, were supplied on computer tape by the bureau. Because these data were rounded up to the nearest year, one year was subtracted to make them consistent with the radiological data, for which rounding down was performed. Based on the bureau's estimates, the round 4 tenure distribution clearly does not represent the general underground mining work force at that time. This is not surprising, given that round 4 participants represent a cohort followed from rounds 1 and 2.

TABLE 3—Tenure in Mining by Round as Defined by the National Study of Coal Workers' Pneumoconiosis

Tenure Group	% Round 1 Miners (n = 9034)	% Round 2 Miners (n = 8385)	% Round 3 Miners (n = 5131)	% Round 4 Miners (n = 3451)	% 1986 Survey Miners (n = 78 741)
0	0.0	2.4	1.1	2.4	2.0
1	10.2	7.4	3.5	1.0	2.0
2–4	10.0	19.9	18.2	2.9	8.9
5–9	7.6	13.2	32.3	12.4	29.2
10–14	5.6	5.8	13.9	26.7	35.0
15–19	8.0	6.0	5.1	29.1	14.1
20–24	14.9	8.5	4.0	9.8	3.6
25–29	16.1	14.4	4.8	5.0	1.6
30+	27.5	22.3	17.1	10.7	3.7

Notes. Data for rounds 1 to 3 reflect the mining work force tenure distributions except for the influence of selective participation. Round 4 was not a cross-sectional study but largely a follow-up group, and the tenure distribution reflects that. The 1986 survey data are projected statistics for coal miners underground and on the surface at underground mines in the bituminous and anthracite areas. They were derived from a Bureau of Mines mail survey of coal mine operators.[30]

Small Rounded Opacities

In every round of the NSCWP, a clear trend of increasing prevalence of CWP with tenure is evident (Figures 2 and 3). Round 4 tenure-specific rates of category 1 or greater small rounded opacities were about one-third those of round 1 (Figure 2), while rates of category 2 or greater opacities showed larger drops from round 1 to round 4 (Figure 3).

Large Opacities

Figure 4 provides information on the prevalence of progressive massive fibrosis. These data for large opacity prevalence are probably more prone to selection effects than are the data for small opacities, given that miners with severe CWP are more likely to leave mining for health reasons (and with compensation provided by the Federal Coal Mine Health and Safety Act ["Black Lung Act"] of 1969). There is a trend toward lower prevalences from round 1 through round 3, which probably reflects the effect of both lower dust exposures and loss of miners with progressive massive fibrosis from the work force. The prevalences at round 4 are similar to those at round 3. The reason for this is not clear although the increased participation rates at round 4 may be responsible. The round 4 data are currently under more detailed study, including an evaluation of 15-year incidence.

Standardized Rates

For each round, estimated summary statistics for small rounded opacity prevalence, obtained from the Bureau of Mines survey data[30] and standardized to the common tenure distribution, were derived for small rounded opacities of category 1 or greater and of category 2 or greater. These are shown in Table 4. They indicate a slight drop in prevalence from round 1 to round 2, an approximate halving in prevalence from round 2 to round 3, and a further drop from round 3 to round 4.

Small Combined Opacities

Although small rounded opacities have been more commonly associated

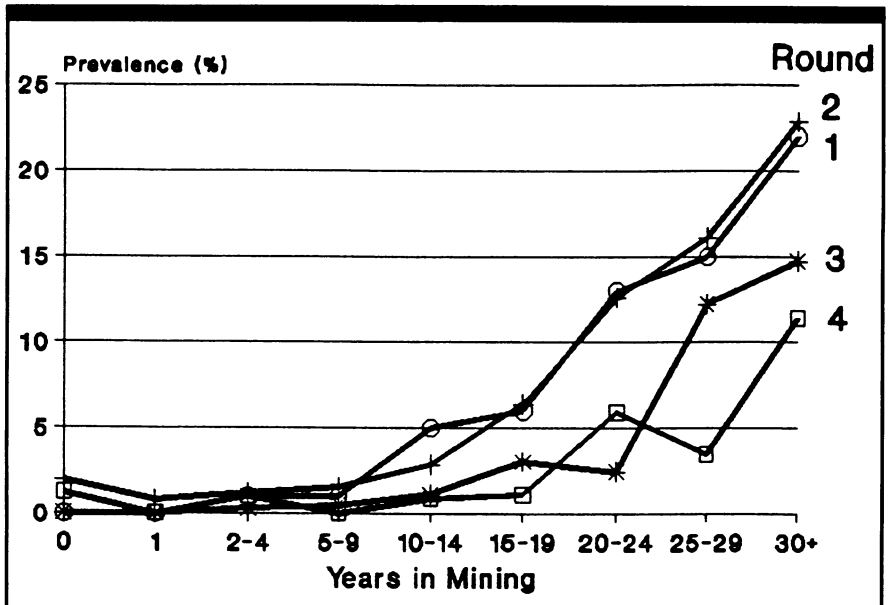

FIGURE 2—Prevalence of category 1 or greater small rounded opacities by round of the National Study of Coal Workers' Pneumoconiosis and by tenure group. Single reader at Round 1; median readings for other rounds.

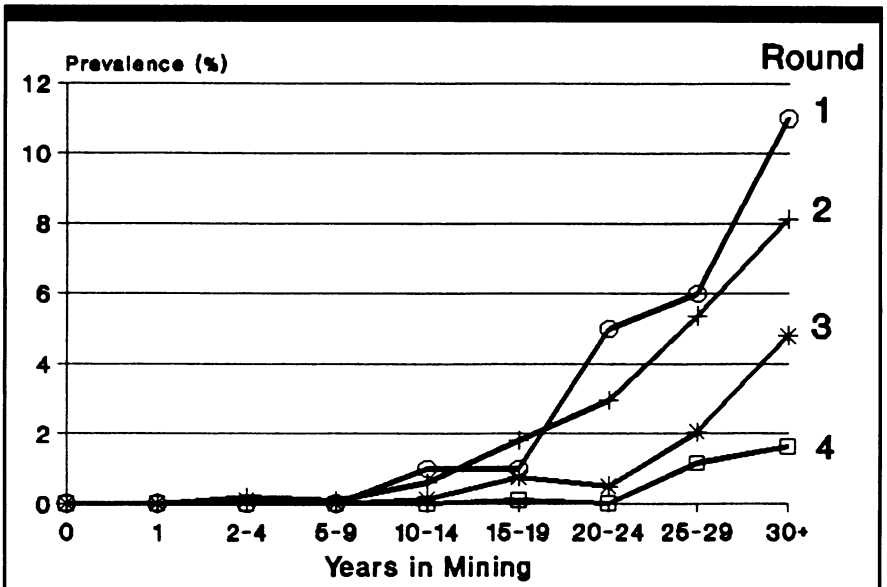

FIGURE 3—Prevalence of category 2 or greater small rounded opacities by round of the National Study of Coal Workers' Pneumoconiosis and by tenure group. Single reader at Round 1; median readings for other rounds.

with CWP, there is some evidence that small irregular opacities may also be associated with coal mine dust exposure.[31] For this reason, and because different readers sometimes report similar profusions yet differ on the predominant type of small opacity on chest radiographs, summary adjusted statistics for combined opacities are also shown in Table 4. These prevalences are somewhat higher, as expected, but do parallel the downward trends seen for small rounded opacities.

Discussion

The prevalences of CWP shown in Figures 2 to 4 and summarized in Table 4 reveal clear downward trends over time. Similar trends are evident in data from a large federal x-ray surveillance program for underground coal miners.[1] Both sets of data suggest that prevalences at round 4 were about a third of their levels at round 1. Reductions in reported prevalence of more severe categories of pneumoconiosis (e.g., category 2 or greater) were somewhat greater.

The observed trends occurred concurrently with reductions in dust exposure mandated by the 1969 Federal Coal Mine Health and Safety Act and recorded by the Mine Safety and Health Administration. According to the report by Parobeck and Jankowski,[32] respirable dust levels in US mines dropped from averages of about 6 mg/m^3 for face jobs in 1968 to 1969 to less than 1.5 mg/m^3 10 years later. Although there is evidence that the actual decline in dust levels may not have been as great as reported,[33,34] it is very likely that most underground coal miners experience lower exposures today than they did prior to passage of the 1969 Federal Coal Mine Health and Safety Act.

Although reductions in dust levels and other CWP prevention measures are the most likely reason for the declines in prevalence of radiological abnormality, there may be some degree of confounding with other effects, such as selective participation and exodus of miners with lung disease from the work force. Artifactual effects associated with x-ray reading, such as the use of different readers and international x-ray classifications systems, and possible changes in readers' perceptions over time may also be confounded with real trends in prevalence. It is difficult to assess how these factors may have influenced the results presented here. To obtain a clearer understanding of temporal trends in the prevalence and severity of CWP in coal miners, a study is planned that will involve the rereading of large numbers of chest radiographs selected from all four rounds of the NSCWP. This will be designed to control for potential confounding associated with these artifactual effects.

The Bureau of Mines survey data given in Table 3 indicate that the 1986 underground coal mining work force was fairly young, with most miners having worked fewer than 20 years in mining. As a consequence, use of this distribution for standardization leads to rates reflecting prevalence among the less experienced miners. If it is preliminary evidence on the efficacy of the current federal dust limit that is being sought, use of this distribution is very appropriate because, to date, only those with limited tenure have been working under the lower dust limits mandated by the 1969 act. However, use of this distribution does not lead to a fair picture of prevalence levels and changes among older miners. Simple averages of the tenure-specific rates for miners with 20 or more years of work in

mining indicate drops from 16.9% to 6.9% for category 1 or greater small rounded opacities, and from 7.1% to 0.9% for category 2 or greater small rounded opacities. As might be expected, the drops in prevalence (as measured by the ratios of the prevalences) are not so marked as those obtained for the summary rates in Table 4. This is probably because many of the older miners in round 4 had substantial lung dust burdens that were gained from exposures received before 1969.

Although reliance on only one reading from round 1 is a less than desirable strategy, it was considered unavoidable if data from that round were to be included in this report. Overall, it was felt that the round 1 data were sufficiently reliable to merit inclusion. Reasons for this were (1) the general consistency of the round 1 data with prevalence trends seen in the following three rounds; (2) the consistency of the prevalence trends in the present data compared with trends seen over the same period in coal miner surveillance data[1]; and (3) the similarity between the prevalences from round 1 and those from studies conducted prior to round 1 (medium and medium-low rank data in Figure 1).

One unexpected feature of the results in this report pertains to the Figure 2 tenure-specific data, which show the round 2 rates to be similar to those for round 1. A similar effect was evident over the same period elsewhere.[1] Some consider that this effect may be at least partially artifactual[35] and associated with differences in the standard reference films for category 1 that accompanied the 1968 and 1971 versions of the ILO classification. This authority and others (private communication) consider that films that would have been classified as category 0 using the 1968 classification (used at round 1) were more likely to be placed in category 1 under the 1971 x-ray classification (used during rounds 2 and 3). As a result, true declines in prevalence would be offset by apparent increases associated with the different ILO classification system used. However, clear declines in prevalence were seen over the same period for category 2 or greater small rounded opacities. Therefore, where no major effect associated with differences in the standard reference films has been suggested, the proposed explanation appears to have some merit.

Because round 4 was designed to be a follow-up study of participants from earlier rounds of the NSCWP, it was organized rather differently from the cross-sectionally based rounds 1 to 3. Hence, it may be incorrect to include its results with

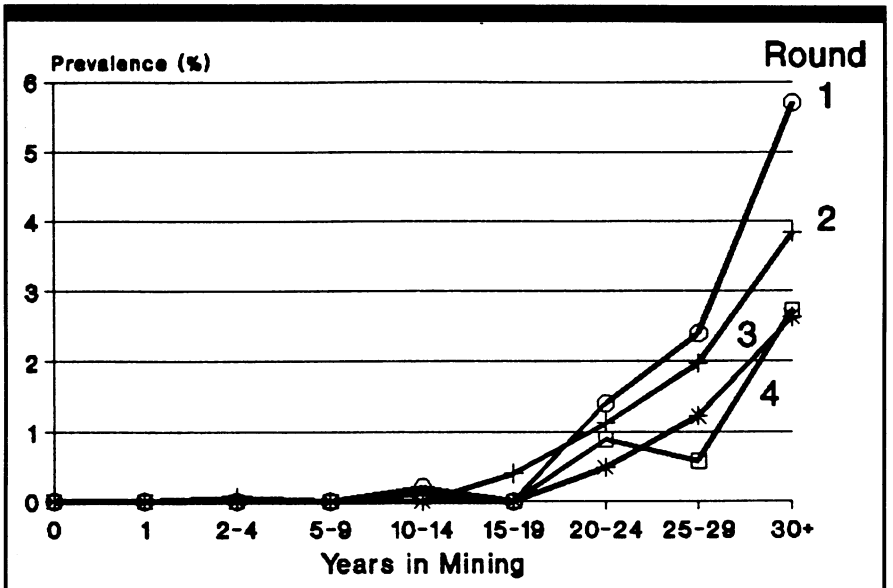

FIGURE 4—Prevalence of progressive massive fibrosis by round of the National Study of Coal Workers' Pneumoconiosis and by tenure group. Single reader at Round 1; median readings for other rounds.

TABLE 4—Summary Coal Workers' Pneumoconiosis Prevalence Statistics from the National Study of Coal Workers' Pneumoconiosis, Based on Small Rounded and Small Combined Opacities, Category 1 or Greater (1+) and Category 2 or Greater (2+), and Adjusted to Common Tenure Distribution

		Adjusted Summary Prevalences, %			
	Category	Round 1	Round 2	Round 3	Round 4
Rounded opacities	1+	4.5	4.1	1.8	1.3
	2+	1.2	1.0	0.4	0.1
Combined opacities	1+	6.6	5.1	3.6	2.3
	2+	1.5	1.2	0.5	0.3

those from the other rounds to assess temporal trends in CWP prevalence. However, because ex-miners who left mining for health-related reasons are excluded from the round 4 results, because the analyses presented are adjusted for tenure, and because most of the ex-miners included left work in mining within a year or two of round 4, inclusion of the round 4 results is probably valid. Further support for their inclusion is provided by results from the surveillance program,[1] in which a similar temporal trend was seen for the same period.

The prevalence data given in this report clearly provide information useful for assessing the efficacy of the current federal dust control regulations in preventing occupational lung disease among underground coal miners. Because this information has its limitations, as noted above, an alternative approach to cross-sectional investigation is the longitudinal study, in which x-ray pairs for individual workers taken over suitable intervals of time are read together under controlled conditions using the same readers and classification system. Such studies have already been undertaken[8,9] and indicate an incidence rate of category 1 or greater small rounded opacities of about 0.5% over 10 years among miners with category 0 on initial examination. This finding is consistent with sharply reduced prevalence rates predicted for the future compared with past levels. Additional longitudinal analyses that include both miners and ex-miners are in progress. Among other things, these will provide needed information on workers who may have left coal mining work because of ill health.

Overall, the results presented here reveal a clear downward trend in the prevalence of CWP in US miners. It seems highly likely that this trend represents a real decline in CWP prevalence, particularly because a similar downward trend has been observed over the same period in data from large numbers of underground coal miners participating in a federal x-ray

examination program.[1] The findings from this report, coupled with those from longitudinal studies,[8,9] suggest that substantial progress has been made in reducing the prevalence of CWP in underground coal miners. However, owing to the limited periods of study and to other methodological difficulties, these findings should not be taken to imply that coal mining is now risk free with respect to CWP. Furthermore, these results provide no information on dust-induced lung diseases other than pneumoconiosis (e.g., chronic bronchitis and airways obstruction). Continued study of both pneumoconiotic and other lung diseases is necessary to ensure adequate protection of the respiratory health of underground coal miners. □

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