

An Investigation into the Relationship Between Coal Workers' Pneumoconiosis and Dust Exposure in U.S. Coal Miners

Detailed Data Collection Methods

Population Studied

Round 1 of the National Study of Coal Workers' Pneumoconiosis (NSCWP) took place between 1969 and 1971. During that time, 31 underground mines situated in all of the major coal fields were visited and the miners examined medically before or after the work shift. The examination consisted of chest x-rays, spirometry, and a questionnaire having sections on work history, smoking history, and chest symptoms. Dust levels at 17 of the 31 mines were sampled intensively between 1968 and 1969. The resulting data, together with those from a number of other large mines were used to calculate personal exposure estimates for the miners at the 31 mines.

X-Ray Readings and Response Variables

X-ray readings obtained between 1969 and 1971 by using the 1968 Union Internationale Centre le Cancer/Cincinnati classification were used. Under this scheme, simple pneumoconiosis is categorized according to profusion of small opacities into four grades: 0, 1, 2, and 3. Two types of opacity are also assessed (rounded and irregular). Only rounded opacity is considered in this paper, partly because rounded opacities are predominantly associated with coal dust exposure and partly to facilitate comparison with results from British studies which, until recently, were based on rounded opacity profusion only.

Although three readers took part in the original film reading, readings for two of them were rejected for this analysis because one did not evaluate the profusion of rounded opacities. The classifications of the others were felt to show unrealistically high levels of abnormality (for example, a 40% prevalence of Category I or greater in miners with 1 year of mining tenure was found). Support for the use of the one reading is discussed later.

Progressive massive fibrosis (PMF) is defined in terms of large opacities, i.e., those greater than 1 cm. A third response variable based on the presence of PMF was also included. As with small opacities, this response was derived from the classifications of the single reader.

Dust Exposures

During the period 1968-1969, intensive dust sampling surveys were undertaken by the Bureau of Mines at a group of small and large underground mines, 17 of which were to be later included in the NSCWP. These data (referred to as the BOM data) appear to be the only body of gravimetric data available prior to 1970 for the NSCWP mines (and on U.S. underground coal mines in general).

To calculate the dust exposure estimates, mean job-specific dust levels based on MSHA compliance data for 1970-1972 were back-extrapolated to pre-1970 levels by using a factor derived from the ratio of the BOM to MSHA 1970-1972 data. Direct use of the BOM data to estimate job mean dust levels was not satisfactory because of missing data for a large number of occupations (primarily noncoal face and surface jobs). The resulting mean concentration estimates were multiplied by miner-supplied job tenure data, summed, and multiplied by 1740 (hr/yr)/1000 (mg per g) to obtain exposures in terms of gram-hours per cubic meter. Mine-adjusted dust exposure estimates were also generated from the basic exposures estimates by using mine-specific dust means. Full details of these procedures are given in another paper.

Breakdown by Coal Type

One factor associated with CWP prevalence and incidence is the rank of coal. Coal rank is often measured by percentage of carbon and varies from about 93% in anthracite, through bituminous coals (78-89% carbon) to sub-bituminous coals and lignite. In the United States, the higher rank coals tend to be in the east with a trend toward lower ranks in the west.

For the purpose of examining the effect of rank of coal in this study, the 31 NSCWP mines were divided into five groups.

1. Anthracite: two mines in eastern Pennsylvania
2. Medium/low volatile bituminous (89-90% carbon): three mines in central Pennsylvania and three in southeastern West Virginia
3. High volatile "A" bituminous (80-87% carbon): 16 mines in western Pennsylvania, north and southwestern West Virginia, eastern Ohio, eastern Kentucky, western Virginia, and Alabama
4. High volatile Midwest: four mines in western Kentucky and Illinois
5. High volatile West: three mines in Utah and Colorado

The latter two groups contained mines for which the rank of the coal was generally lower than in the high volatile "A" bituminous group.