CURRENT INTELLIGENCE BULLETIN 64

Coal Mine Dust Exposures and Associated Health Outcomes

A Review of Information Published Since 1995

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Centers for Disease Control and Prevention
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DHHS (NIOSH) Publication No. 2011–172

April 2011

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Foreword

Since its inception in 1970 the National Institute for Occupational Safety and Health (NIOSH) has extensively investigated and assessed coal miner morbidity and mortality. This history of research encompasses epidemiology; medical surveillance; laboratory-based toxicology, biochemistry, physiology, and pathology; exposure assessment; disease prevention approaches; and methods development. The experience gained in those activities, together with knowledge from external publications and reports, was brought together in 1995 in a major NIOSH review and report of recommendations, entitled *Criteria for a Recommended Standard—Occupational Exposure to Respirable Coal Mine Dust*. This document had the following major recommendations:

1. Exposures to respirable coal mine dust should be limited to 1 mg/m^3 as a time-weighted average concentration for up to a 10 hour day during a 40 hour work week;
2. Exposures to respirable crystalline silica should be limited to 0.05 mg/m^3 as a time-weighted average concentration for up to a 10 hour day during a 40 hour work week;
3. The periodic medical examination for coal miners should include spirometry;
4. Periodic medical examinations should include a standardized respiratory symptom questionnaire;
5. Surface coal miners should be added to and included in the periodic medical monitoring.

This Current Intelligence Bulletin (CIB) updates the information on coal mine dust exposures and associated health effects from 1995 to the present. A principal intent is to determine whether the 1995 recommendations remain valid in the light of the new findings, and whether they need to be updated or supplemented. The report does not deal with issues of sampling and analytical feasibility nor technical feasibility in achieving compliance.

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Executive Summary

Information relating to occupational pulmonary disease morbidity and mortality of coal miners available up to 1995 was reviewed in the NIOSH publication: *Criteria for a Recommended Standard—Occupational Exposure to Respirable Coal Mine Dust*, or Coal Criteria Document (CCD). This led to the following principal conclusions concerning health effects associated with coal mining:

1. Exposure to coal mine dust causes various pulmonary diseases, including coal workers' pneumoconiosis (CWP) and chronic obstructive pulmonary disease (COPD).
2. Coal miners are also exposed to crystalline silica dust, which causes silicosis, COPD, and other diseases.
3. These lung diseases can bring about impairment, disability and premature death.

This Current Intelligence Bulletin updates the previously published review with respect to findings relevant to the health of U.S. coal miners published since 1995. The main conclusions are:

1. After a long period of declining CWP prevalence, recent surveillance data indicate that the prevalence is rising.
2. Coal miners are developing severe CWP at relatively young ages (<50 years).
3. There is some indication that early development of CWP is being manifested as premature mortality.
4. The above individuals would have been employed all of their working lives in environmental conditions mandated by the 1969 Coal Mine Health and Safety Act.
5. The increase in CWP occurrence appears to be concentrated in hot spots of disease mostly concentrated in the central Appalachian region of southern West Virginia, eastern Kentucky, and western Virginia.
6. The cause of this resurgence in disease is likely multifactorial. Possible explanations include excessive exposure due to increases in coal mine dust levels and duration of exposure (longer working hours), and increases in crystalline silica exposure (see below). As indicated by data on disease prevalence and severity, workers in smaller mines may be at special risk.
7. Given that the more productive seams of coal are being mined out, a transition by the industry to mining thinner coal seams and those with more rock

intrusions is taking place and will likely accelerate in the future. Concomitant with this is the likelihood of increased potential for exposure to crystalline silica, and associated increased risk of silicosis, in coal mining.

The main conclusions drawn from review of the new information are:

1. While findings published since 1995 refine or add further to the understanding of the respiratory health effects of coal mine dust described in the NIOSH CCD, they do not contradict or critically modify the primary conclusions and associated recommendations given there. Rather, the new findings strengthen those conclusions and recommendations.
2. Overall, the evidence and logical basis for recommendations concerning prevention of occupational respiratory disease among coal miners remains essentially unaffected by the newer findings that have emerged since publication of the CCD.

In summary, as recommended by the CCD, every effort needs to be made to reduce exposure to both coal mine dust and to crystalline silica dust. As also recommended in the CCD, the latter task requires establishing a separate compliance standard in order to provide an effective limit to exposure to crystalline silica dust.

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Abbreviations

CAO	chronic airway obstruction
CCD	coal criteria document, formally *NIOSH Criteria for a Recommended Standard—Occupational Exposure to Respirable Coal Mine Dust*
COPD	chronic obstructive pulmonary disease
CWP	coal workers' pneumoconiosis
CWXSP	Coal Workers' X-ray Surveillance Program
FEV_1	forced expiratory volume in 1 second
ILO	International Labour Office
mg/m^3	milligrams per cubic meter
MSHA	Mine Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
PAH	polycyclic aromatic hydrocarbons
PDM	personal continuous dust monitor
PMF	progressive massive fibrosis
REL	recommended exposure limit
YPLL	years of potential life lost

Glossary

Aerodynamic diameter: The diameter of a sphere with a density of 1 g/cm^3 and with the same stopping time as the particle. Particles of a given aerodynamic diameter move within the air spaces of the respiratory system identically, regardless of density or shape.

Chronic obstructive pulmonary disease (COPD): Includes chronic bronchitis (inflammation of the lung airways associated with cough and phlegm production), impaired lung function, and emphysema (destruction of the air spaces where gas transfer occurs). COPD is characterized by irreversible (although sometimes variable) obstruction of lung airways, and should be considered in any patient who has dyspnea, chronic cough or sputum, and/or a history of exposure to risk factors for COPD. The diagnosis should be confirmed by spirometry.

Coal rank: A classification of coal based on fixed carbon, volatile matter, and heating value of the coal. Coal rank indicates the progressive geological alteration (coalification) from lignite to anthracite.

Coal workers' pneumoconiosis (CWP): A chronic dust disease of the lung arising from employment in a coal mine. In workers who are or have been exposed to coal mine dust, diagnosis is based on the radiographic classification of the size, shape, profusion, and extent of parenchymal opacities.

Crystalline silica: Silicon dioxide (SiO_2). "Crystalline" refers to the orientation of SiO_2 molecules in a fixed pattern as opposed to a nonperiodic, random molecular arrangement defined as amorphous. The three most common crystalline forms of free silica encountered in general industry are quartz, tridymite, and cristobalite. The predominant form is quartz.

Excess (exposure-attributable) prevalence: The prevalence (cases/population at risk) attributable to workplace dust exposure (in the case of CWP, the prevalence adjusted for radiographic appearances associated with lung aging).

International Labour Office (ILO) classification system: A standardized method for assessing abnormalities related to the pneumoconioses based substantially on comparison of test with reference radiographs. In the system there are 4 categories of simple pneumoconiosis (categories 0, 1, 2, and 3), with 0 implying no definite abnormality.

Progressive massive fibrosis: Coal workers' complicated pneumoconiosis. Diagnosis is based on determination of the presence of large opacities (1 cm or larger) using radiography or the finding of specific lung pathology on biopsy or autopsy.

Quartz: Crystalline silicon dioxide (SiO_2) not chemically combined with other substances and having a distinctive physical structure.

Respirable coal mine dust: That portion of airborne dust in coal mines that is capable of entering the gas-exchange regions of the lungs if inhaled: by convention, a particle-size-selective fraction of the total airborne dust; includes particles with aerodynamic diameters less than approximately 10 μm.

Acknowledgments

Michael Attfield was the primary author of this document, which was prepared in the Division of Respiratory Disease Studies, NIOSH, under the direction of Dr. David Weissman. He acknowledges the following assistance in the preparation of the report:

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Health Effects Laboratory Division (HELD)

Vincent Castranova, Kimberly Clough Thomas

This Current Intelligence Bulletin has undergone substantial internal and external scientific peer review with subsequent revision. A draft version of the document was published on the NIOSH website for public comment for 60 days, with notification of its availability via the Federal Register. All input, both internal and external, has been considered, addressed, and responded to in preparation of this final version.

Internal NIOSH reviewers who provided critical feedback to the preparation of the document

Eileen Kuempel, Education and Information Division (EID). Ed Thimons, Office of Mine Safety and Health Research (OMSHR), Robert Castellan (DRDS), Ainsley Weston (DRDS), Eileen Storey (DRDS).

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NIOSH expresses appreciation to the following independent, external reviewers for providing insights and comments that contributed to the development of this document and enhanced the final version:

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1 Introduction

The publication of the *NIOSH Criteria for a Recommended Standard—Occupational Exposure to Respirable Coal Mine Dust* or Coal Criteria Document (CCD) in 1995 (1) followed a long period of extensive research activity focused on exposure to coal mine dust and its health effects in coal miners. From this research, substantial information had emerged about the extent and severity of respiratory disease caused by coal mine dust, its quantitative relationship with dust exposure, its pathology and toxicology, environmental patterns of relevant exposures, and methodologies for assessing these variables. In particular, the findings demonstrated that not only was there a considerable burden of coal workers' pneumoconiosis (CWP) in the U.S. and other countries, but that underground coal miners were vulnerable to other lung diseases, notably chronic obstructive pulmonary disease (COPD). The evidence came from extensive and well-planned epidemiologic and laboratory-based investigations undertaken primarily in the U.S., the United Kingdom, and (West) Germany, with supporting information coming from studies in other European countries and Australia.

The available information was thoroughly summarized in the CCD. It showed that, in 1995, CWP was in decline in the U.S., with downward trends in prevalence in all tenure groups (Figure 4–2 of the CCD (1), included here as Figure 1). This decline was consistent with reductions in coal mine dust exposure mandated by the 1969 Coal Mine Health and Safety Act (1969 Coal Mine Act) (CCD Figure 4–1 (1); Figure 2). Despite this decline in disease levels, NIOSH concluded from review of the surveillance data and quantitative risk estimates based on the epidemiologic studies that the current dust exposure regulations for U.S. coal mines were not sufficiently protective. Consequently, it proposed lower dust limits for coal mines, enhanced medical surveillance, and other requirements.

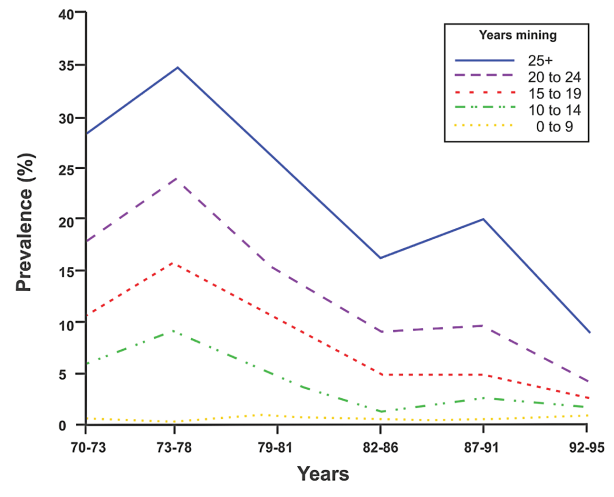

Figure 1. Prevalence of CWP category 1 or greater from the NIOSH Coal Workers' X-ray Program from 1970–1995, by tenure in coal mining. (Figure 4–2 of the CCD (1)).