



Women in Coal Mining—Radiographic Findings of Women Participants in the Coal Workers' Health Surveillance Program 1970–2022

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Abstract

Objective: To describe the work experience and respiratory health of women coal miners in the United States using Coal Workers' Health Surveillance Program (CWHSP) data.

Methods: Analysis included CWHSP participants with self-reported sex of female between January 1, 1970, and December 31, 2022, and examined radiographic surveillance, demographics, and job history. National Institute for Occupational Safety and Health-certified physicians classified chest radiographs.

Results: Among 8,182 women participants, most worked <10 years and a majority reported working in non-dusty jobs. Among 3,392 with ≥1 year of coal mining tenure, 18 (0.5%) had evidence of pneumoconiosis, with no cases of progressive massive fibrosis.

Conclusion: Women coal miners participating in the CWSHP had short mining careers and low pneumoconiosis prevalence. Few worked in the most dusty jobs, indicating limited exposure to coal mine dust. This underscores the need to explore women's roles in mining, and for improved gender-specific employment reporting. Such changes can enhance health and work conditions for women in male-dominated industries.

Keywords: occupational, pneumoconiosis, respiratory, surveillance, mining

Introduction

Scholars have attributed the first commercial use of coal in the United States to coal extracted from the Manakin area (Richmond, Virginia) in 1701.¹ By the late 1700s, the value of coal was widely known and the process of small- and large-scale extraction was taking place throughout Appalachia and the Illinois basin. While women often worked in coal camps to provide meals and do clerical work, their participation in mining activities was largely prohibited by social norms of the time, including the common belief that women underground brought bad luck.²

In the 1800s, these prohibitions were formalized with state governments instituting policies modeled after an 1842 British law³ that banned U.S. women from underground coal

mining and fined violators.⁴ By 1932, 17 states had laws strictly prohibiting women from working in underground mines.⁵ Despite these prohibitions, women loading manual coal carts, sorting and cleaning coal (picking rock), and laying tracks has been documented throughout this period. It is not entirely clear the full extent women played in underground coal mining during the push to put women to work in the industrial workforce throughout the first and second World Wars. However, the role of women in underground coal mining remained limited despite notable increases in other industrial sectors.^{2,6,7}

Throughout the 20th century, discrimination against women and racial minorities continued to prevent their full participation in the U.S. mining industry. Exclusion of women from coal mining jobs persisted despite passage of

the Civil Rights Act of 1964 and Executive Order 11246, signed by President Lyndon B. Johnson on September 24, 1965, establishing requirements for nondiscriminatory practices in hiring and employment on the part of U.S. government contractors. This order was amended in 1967 to include gender as a basis for nondiscrimination. However, before the enactment of the Pregnancy Discrimination Act of 1978, hiring and employment discrimination on the basis of pregnancy status continued to impact working women for another decade.⁸

It was not until 1973 that a consent decree forced the U.S. steel industry to hire women in the steel-owned coal mines.⁹ This led to increased hiring of women in the coal mining industry, and the development of the COAL EMPLOYMENT PROJECT (CEP) to address “historical patterns of discrimination (that) denied women opportunities for employment in Appalachia’s dominant industry. CEP was launched as an advocate for addressing the issue. CEP was born, however, out of an act of sex discrimination which denied a woman the right even to visit a mine.”¹⁰ Though industrial coal mining has been ongoing for over 300 years and wives of miners routinely participated in union activities in the early and mid-1900s, U.S. women were not formally recognized and included within the coal mining workforce until 1974, when Diana Baldwin and Anita Cherry descended with their male counterparts into coal mine No. 29 near Jenkins, Kentucky.¹¹

The Federal Coal Mine Health and Safety Act of 1969 (predecessor to the Federal Mine Safety and Health Act of 1977) was established to improve working conditions in the nation’s coal mines.^{12,13} As part of that legislation, periodic chest radiographs were provided to underground coal miners at no cost to themselves throughout their working careers. The National Institute for Occupational Safety and Health (NIOSH) has administered the Coal Workers Health Surveillance Program (CWHSP) since its establishment in 1971.¹⁴ Periodic reporting of these data have been ongoing throughout this period and have generally focused on the prevalence of pneumoconiosis among the entire mining workforce and have not reported data specific to sex or race, due to low numbers of participants other than White men.

Though coal mining has historically been and continues to be a White male-dominated industry, women miners have comprised an estimated 5–10% of the workforce since the late 1970s.¹⁵ Not only have women been underrepresented in hiring and employment in the coal industry, but they have also not been routinely represented in reports describing the respiratory health of coal miners, including those using CWHSP data. This omission can be attributed to the epidemiologic tendency to either aggregate or exclude groups with low numbers from analysis. Regardless of intention, these reporting practices have not allowed for the assessment of respiratory impairment by gender among coal miners and may mask health inequities, a focus of CDC research in recent years.¹⁶ This interest in health equity has stemmed largely from a government-wide initiative promoting diversity and inclusion, which highlights the need for gender equity in the workforce.¹⁷ A recent publication exploring the experience of women in mining, not limited to coal, notes that insufficient data are available to adequately describe the experience and health of women in mining, and that these are “issues in critical need of additional research efforts,”

while specifying that “mining-specific surveillance data are needed.”¹⁵ To address this issue, we review the 53-year history of X-rays and accompanying data collected from women coal miner participants of the CWHSP to characterize their participation over time and describe employment and disease characteristics in this underrepresented population.

Methods

Miners who participated in the CWHSP at least once during January 1, 1970–December 31, 2022 with a self-reported sex of female were included in analysis. The NIOSH CWHSP has a non-research designation (NIOSH IRB:11-DRDS-NR03) as a surveillance activity. All participants provided written informed consent to participate in the CWHSP. Participation in radiographic surveillance has been mandatory for new coal miners within their first 6 months of employment since June 30, 1971. Since August 1, 2014, this requirement was updated to require participation in surveillance within the first 30 days of employment. After the new miner’s initial encounter, a follow-up within 3 years of that initial respiratory health screening has been mandatory since June 30, 1971. For the remainder of the coal miner’s career, participation in the CWHSP is voluntary, as described elsewhere.^{18,19} Since August 1, 2014, surface and contractor miners were also included systematically in the CWHSP.²⁰

Demographic data were collected through the CWHSP including mining tenure, age, race, and ethnicity. Detailed work history was available for CWHSP participants starting in 1992, including most common job worked at each mine throughout their tenure. Dusty jobs are defined as those jobs that are associated with the highest burden of coal mine dust exposure, typically in close proximity to the coal face, where production occurs. In underground mining, these include long-wall operators, continuous miner operators, cutting machine operators, augerers, and roof bolters.²¹ In surface mining, these include drillers and blasters.²² Each chest radiograph was classified by at least two NIOSH-certified physicians (digital images classified by B Readers only, film-based images by A and B Readers) with summary classifications reached as specified in U.S. regulations.¹⁹ Radiographs were classified according to the International Labor Office (ILO) classification system.²³ Radiographs with small opacity profusion of 1/0 or greater were classified as presence of pneumoconiosis, while the presence of large opacities (>1cm in diameter) were classified as progressive massive fibrosis (PMF), the most severe form of pneumoconiosis. Analysis of CWHSP data was completed in SAS 9.4 (Cary, NC).

Results

A total of 8,182 women coal miners participated in the CWHSP during January 1, 1970–December 31, 2022. Of these, 4,790 (58.5%) only participated as a new miner, with zero full years of tenure reported. The median age for these new miners with one encounter was 27 years, while the median age at the first encounter for all women miners participating in the CWHSP was 30 years. Of those participating miners with non-zero tenure, 68.3% reported working fewer than 10 years at their most recent CWHSP encounter. The median tenure reported for

TABLE 1. DEMOGRAPHICS, MINING TENURE, AND PNEUMOCONIOSIS STATUS OF WOMEN MINERS IN THE NIOSH CWHSP, 1970–2022

| <i>Characteristics</i> | |
|--|---------------|
| Total women participants | 8,182 |
| Age at first encounter, median (range), years | 30 (16–72) |
| Race | |
| White, <i>n</i> (%) | 7,284 (89.0%) |
| Black, <i>n</i> (%) | 466 (5.7%) |
| American Indian/Alaskan Native, <i>n</i> (%) | 289 (3.5%) |
| Asian/Pacific Islander, <i>n</i> (%) | 22 (0.3%) |
| Coal mining region ^a | |
| Western, <i>n</i> (%) | 2,956 (36.1%) |
| Central Appalachian, <i>n</i> (%) | 2,716 (33.2%) |
| Interior, <i>n</i> (%) | 1,287 (15.7%) |
| Eastern, <i>n</i> (%) | 1,223 (14.9%) |
| Tenure | |
| New miners (0 years), <i>n</i> (%) | 4,790 (58.5%) |
| 1–9 years, <i>n</i> (%) | 2,315 (28.3%) |
| 10–14 years, <i>n</i> (%) | 380 (4.6%) |
| 15–19 years, <i>n</i> (%) | 262 (3.2%) |
| 20–24 years, <i>n</i> (%) | 215 (2.6%) |
| ≥25 years, <i>n</i> (%) | 220 (2.7%) |
| Miners with ≥1 year tenure | 3,392 |
| Tenure at most recent encounter, median (range), years | 5 (1–42) |
| Pneumoconiosis, <i>n</i> (%) | 18 (0.5%) |
| Most common jobs held ^b | |
| Laborer, <i>n</i> (%) | 497 (21.6%) |
| Coal truck driver, <i>n</i> (%) | 238 (10.4%) |
| Clerk / timekeeper, <i>n</i> (%) | 234 (10.2%) |
| Bulldozer / heavy equipment operator, <i>n</i> (%) | 233 (10.2%) |
| Warehouse, <i>n</i> (%) | 208 (9.1%) |
| Ever Held a dusty job ^c , <i>n</i> (%) | 235 (10.2%) |

^aCoal mining regions are comprised of the following states: Western: Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming; Central Appalachian: Kentucky, Virginia, West Virginia; Interior: Arkansas, Illinois, Indiana, Iowa, Kansas, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Oklahoma, Texas, Wisconsin; Eastern: Alabama, Florida, Georgia, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, and Tennessee.

^bJob history was available for 2,298 women miners. More than 1 job may be listed in the job history form. The job types listed are not mutually exclusive.

^cDusty jobs are any of the following jobs: longwall operators, continuous miner operators, cutting machine operators, augerers, roof bolters, and drillers and blasters.

experienced miners at their most recent encounter with CWHSP was 5 years, ranging from 1 to 42 years (Table 1).

Participation in the CWHSP varied over time, with the highest single-year participation among women occurring in 1979 ($n = 723$), and the lowest occurring in 1996 ($n = 20$) (Fig. 1). Of the 2,337 women who participated during 2014–2022, 84.3% worked at a surface mine ($n = 1,290$) or as a contractor ($n = 680$) at the time of their participation. As surface miners and contractors were not systematically included in CWHSP before 2014, only 27.6% of the 5,845 participating women during 1970–2013 worked at a surface mine ($n = 1,614$) or as a contractor ($n = 1$).

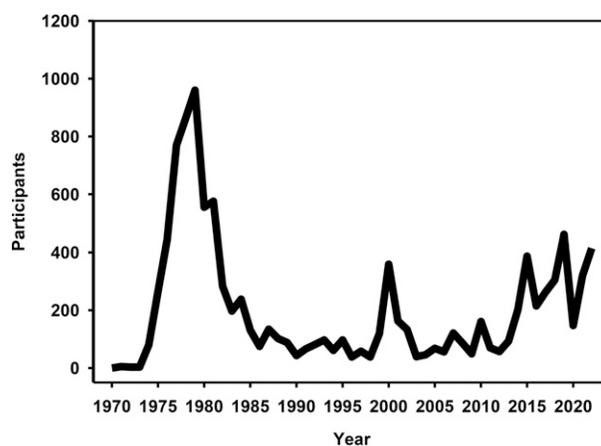


FIG. 1. Women Participants in the Coal Workers' Health Surveillance Program by Year, 1970–2022.

Among women coal miners, 2,298 had a self-reported job history available. This included 183 new miners with zero full years of mining tenure reported. Of the remaining 2,115 experienced miners with one or more years of tenure reported, the majority ($n = 1,314$, 62.1%) reported holding only 1 job. Of the 2,298 women miners with job history available, 235 (10.2%) reported ever working a dusty job, such as roof bolter, continuous mining machine operator, and driller or blaster. The most commonly reported jobs among all women miners were laborer (497, 21.6%), coal truck driver (238, 10.4%), time clerk (234, 10.2%), bulldozer/heavy equipment operator (233, 10.1%), and warehouse (208, 9.1%).

Among the 3,392 women coal miners with at least 1 year of coal mining tenure reported, 18 (0.5%) had evidence of pneumoconiosis on their most recent radiograph. These miners had a median tenure of 6.5 years with 15 having category 1 profusion, 2 having category 2 profusion, and 1 having category 3 profusion. Of these 18, 10 were surface miners and 8 were underground miners. Of the 9 women with job history recorded, only 2 reported ever having worked a dusty job. No women were identified with progressive massive fibrosis.

Discussion

In examining women coal miners in the CWHSP, our findings indicate that women participants have relatively short mining tenures, few were identified with pneumoconiosis, and the number of participants on an annual basis varied greatly over the past 5 decades. In describing the participation and respiratory health of women coal miners, this study highlights important trends but also exposes several knowledge gaps and potential concerns.

First, there is a lack of systematic accounting of women's employment in the coal mining industry. The Department of Labor tracks quarterly mine employment numbers reported by the U.S. ENERGY INFORMATION ADMINISTRATION. However, gender is aggregated in these reports.²⁴ Other surveys have calculated gender-based employment estimates, though these are based on small sample sizes, leading to wide variability in those estimates.²⁵ To our knowledge, there is no global census or precision in the

estimated number of women employed in the coal industry today. Additionally, estimating employment of women miners based on their participation in the CWHSP may not reflect reality, underscoring the need for more precise data collection. Accurate data are crucial for understanding the true scale of women's involvement in mining and their health outcomes.

Participation in the CWHSP is voluntary after initial screenings for new miners, and we have previously reported that the mandated participation in screening upon job entry is not systematically enforced.¹⁸ For the past 20 years, between 35–40% of all employed miners participate in the CWHSP, which includes both new miners and miners participating throughout their mining career.¹⁸ The voluntary aspect of the CWHSP could affect our understanding of the respiratory health of women in the industry. Without a reliable denominator, the true participation rate among women miners remains unknown. However, increases (spikes) in the number of women participants in the CWHSP over time (Fig. 1) are likely the result of specific initiatives aimed at encouraging the involvement of miners in health surveillance programs and should be considered as models for future approaches to improve participation.

For example, initiatives like the Coal Employment Project in the 1970s were pivotal in opening up the industry to women.^{2,10} The “Miners’ Choice” program, which operated from 1999 to 2002, was a collaborative effort by NIOSH and the Mine Safety and Health Administration (MSHA), which encouraged participation in CWHSP by providing radiographical surveillance at no cost to miners or mine operators. The outreach was directed at both underground and surface miners and likely contributed to the increase in program participation during that period. Further, the influx of women participating in the CWHSP in 2014 and beyond can likely be attributed to the program's expansion, which began systematically including surface and contracted coal miners following implementation of the 2014 MSHA respirable coal mine dust rule.²⁶

A key finding of this analysis is the relatively short tenure of women in coal mining. It is important to note that this reflects the tenure reported at their most recent encounter with the CWHSP and final tenure within the coal mining industry is unknown. However, a study linking CWHSP with a workers' compensation dataset indicated that median final mining tenures verified by employment records were approximately 2 years longer than the median total mining tenure recorded through the CWHSP.²⁷ The shorter mining tenures observed for women miners could be owing to various factors including workplace discrimination, sexual harassment, or other barriers to continued employment.^{28,29} This shorter tenure also likely contributes to the lower identified rates of pneumoconiosis in women, as pneumoconiosis has classically been considered a disease of long latency.³⁰ The overall low prevalence of pneumoconiosis and the complete absence of PMF among women participants in the CWHSP raises questions about the intersection of occupational exposure, occupational opportunity, and the systems that create and reinforce a society's cultural norms of roles, expectations, and value based on a person's gender.

Among women who had job history available, 10.2% had ever worked a dusty job, whereas the most commonly reported job worked by women miners was the role of

general laborer. This suggests that women are not provided the opportunity to work in the most highly skilled and highest paying positions in mining, which coincidentally are often those positions with the highest exposure to coal mine dust.^{21,22} It is not that women coal miners are inherently less likely to develop disease, but rather that they may simply not be afforded the “opportunity” to develop severe disease, as earning higher wages may come with greater exposures to coal mine dust. Lack of upward job mobility is both a plausible explanation for the low prevalence of pneumoconiosis we observe in this analysis and a plausible explanation for the observed low tenures. If miners are not provided opportunity for advancement and access to the highest paid positions, they may seek employment elsewhere.

Public Health Implications

Given the voluntary nature of CWHSP participation, and the potential for underrepresentation of women, focused outreach to women in the industry is warranted. Focused messaging encouraging more women coal miners to participate in the CWHSP could provide a more comprehensive understanding of their respiratory health risks and experiences in the mining sector. Analyzing participant data from the CWHSP to understand the health and experience of women in coal mining over time underscores the significance of legislative and advocacy efforts that have shaped the industry's dynamics. These findings necessitate a closer examination of why women leave the industry as well as what health impacts they might be experiencing post-employment. Utilizing other available data sources, such as medical records or mining industry accident and injury reports, can help further our current limited understanding of women's issues in mining. Future research in these areas could help to address issues of health and employment equity and inform strategies to improve the working conditions and health outcomes of women in this and other male-dominated industries.

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Authors' Contributions

N.B.H.: analyzed and interpreted the data, led writing of the article and takes responsibility for its content. D.J.B., L.E.R., N.T.M.: assisted with interpreting data and writing the article. A.S.L.: conceptualized and designed the study and helped with data interpretation and writing.

Disclaimer

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