Received: 22 September 2021 | Revised: 15 December 2021 | Accepted: 3 January 2022

DOI: 10.1002/ajim.23324

BRIEF REPORT

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE WILEY

Respiratory health of American Indian and Alaska Native coal miners participating in the Coal Workers' Health Surveillance Program, 2014–2019

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Funding information
Cooperative Agreement from the Centers for Disease Control and Prevention and the Association of Schools and Programs of Public Health, Grant/Award Number: NU36OE000006

Abstract

Background: In 2014, a federal rule reduced occupational exposure limits to coal mine dust and expanded medical surveillance eligibility beyond underground miners to surface and contract coal miners. This expansion may have provided an opportunity for more American Indian and Alaska Native (AI/AN) coal miners to participate in screening, since many surface coal mines are located near AI/AN communities and may employ AI/AN miners. Therefore we sought to better understand the respiratory health of AI/AN coal miners by characterizing prevalence of coal workers' pneumoconiosis (CWP), progressive massive fibrosis (PMF), and abnormal lung function in this population.

Methods: Descriptive analysis of 1405 chest radiographs and 627 spirometry test results for AI/AN miners who participated in the Coal Workers' Health Surveillance Program (CWHSP) during 2014–2019 was conducted.

Results: Most AI/AN miners (0–25+ years of tenure) were western United States residents (82.3%) and active surface miners (76.9%) with no underground tenure. Among miners with at least 10 years of tenure, prevalence of CWP was 3.0%, and of PMF was 0.3%. Lung function abnormalities were seen in 9.0% with primarily restrictive patterns.

Conclusions: The prevalence of CWP, PMF, and lung function abnormality among active and former AI/AN coal miners was higher than seen in a larger CWHSP study of active western miners working primarily underground with 10+ years of tenure. Interventions that eliminate or control coal mine dust exposure, identify miners with CWP early, and limit respiratory disease progression and complications remain vital for eliminating the preventable adverse health effects of coal mining. Comprehensive demographic data on the coal mining workforce are needed to improve CWHSP participation assessment.

Noemi B. Hall and Maya J. Nye contributed equally as first authors.

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KEYWORDS

American Indian and Alaska Native, coal miners, lung function, pneumoconiosis, spirometry, surveillance

1 | INTRODUCTION

Coal workers' pneumoconiosis (CWP, or "black lung") is a chronic and irreversible lung disease solely caused by occupational exposure to respirable coal mine dust.[1] Decreased lung function is also associated with respirable coal mine dust exposure and has been observed among miners with and without radiographic evidence of CWP.[2] Since 2000, an increased prevalence of progressive massive fibrosis (PMF), the most severe form of CWP, has been observed among Appalachian underground miners and clusters of surface coal miners with no underground experience, most notably in drillers and blasters exposed to high concentrations of respirable crystalline silica dust.[1,3] Eventually, CWP and PMF can lead to premature death. The primary intervention recommended by the U.S. National Institute for Occupational Safety and Health (NIOSH) for minimizing CWP morbidity and mortality is limiting exposure to respirable coal mine dust and crystalline silica dust using administrative and engineering controls.[1] Secondary prevention interventions may include health surveillance for early disease detection and an administrative option for miners with evidence of CWP to transfer to a less dusty job.

NIOSH's Coal Workers' Health Surveillance Program (CWHSP) is the only federally mandated respiratory health surveillance program designed to identify miners with CWP.[1] It has provided periodic chest radiograph screenings for eligible active underground miners since 1970. Data from the CWHSP are used to monitor trends and regional distribution of CWP and abnormal lung function among miners. Clinics approved by NIOSH provide these screenings to miners and miner participation in the program is voluntary. Additionally, a NIOSH mobile unit has been operational since 2005 and supplements the CWHSP by traveling to different coal mining regions to provide screenings. The CWHSP began offering spirometry in the NIOSH mobile unit in 2005 and at NIOSH-approved clinics in 2016.

In 2014, the Mining Safety and Health Administration issued a final rule that reduced permissible limits for coal dust exposure implemented the use of a continuous personal dust monitor (CPDM) and enhanced medical surveillance screening options for miners.[1] In response to this rule, NIOSH expanded the CWHSP to include surface and contract miners and a health and work questionnaire. Since this enhancement, the CWHSP has collected data from surface mines, many of which employ American Indian and Alaska Native (AI/AN) miners. Available data suggest that between 2014 and 2019, a 2% annual estimated average ($n = 1859/91{,}359$)[4,5] of all U.S. coal miners were AI/AN. Understanding disease prevalence among AI/AN miners is necessary to establish a baseline to understand trends over time in this traditionally medically underserved population. Prevalence of CWP, PMF, and abnormal lung function among AI/AN coal miners have not previously been analyzed using CWHSP data. The objective of this study was to address this gap.

2 | MATERIALS AND METHODS

CWHSP data from January 1, 2014 to December 31, 2019, including demographics, health and work histories, chest radiograph final determinations, and spirometry tests were analyzed for miners who ever self-identified as AI/AN from multiple-race options on the CWHSP questionnaires. Radiographs were classified according to International Labour Office guidelines.[6] CWP was defined as the radiographic presence of small opacities <1 cm with a profusion of ≥1/0, and PMF as radiographic presence of large opacities >1 cm^3. For miners who had multiple radiographs with CWP or PMF final determinations, the most recent reading indicating disease was analyzed. For all other miners, the final determination from their most recent CWHSP encounter was used. Spirometry tests were administered according to American Thoracic Society guidelines.[7] Test results that met repeatability and acceptability criteria[3] were included for analysis and interpreted using race/ethnicity-based corrections to predict the lower limits of normal lung function in the population.[8] Reference values for non-Hispanic Whites were used to interpret spirometry results for AI/AN miners if no additional race or ethnicity had been indicated. The pattern of impairment was classified as obstructive, restrictive, or mixed based on established guidelines.[3] Never smokers were miners who self-reported smoking <100 cigarettes in their lifetime. Analysis was conducted using SAS version 9.4 (SAS Institute). The CWHSP has a nonresearch designation (11-DRDS-NR03) as a surveillance activity. All participants provided written informed consent to participate in the CWHSP.

3 | RESULTS

Demographic information, work histories, and radiographs with final determinations were available for 1405 miners. AI/AN miners were predominantly male (90.4%) with a median age of 48 years (range 18–91) and western United States (82.4%) residents. The median tenure was 11 years (range 0–54), and of 1057 miners with at least 1 year of tenure, 76.9% were surface miners with no underground experience. Most were active miners (92.2%), 33.0% of whom worked at mines with <50 employees. Among the 763 miners with at least 10 years of tenure, there were 23 (3.0%) miners with evidence of CWP, and two (0.3%) with evidence of PMF. Among miners with fewer than 10 years of tenure, four had evidence of CWP (Table 1).

TABLE 1 Demographics, work history, and respiratory health of AI/AN coal miner participants, NIOSH CWHSP, 2014–2019

Total AI/AN, *n* (%)	1405 (100.0)
Miner characteristics	
Male, *n* (%)	1270 (90.4)
Age (years), median (range)	48 (18–91)
Hispanic ethnicity, *n* (%)	64 (4.6)
Western region, *n* (%)	1156 (82.3)
Coal mining tenure (years), median (range)	11 (0–54)
New miners (0-years tenure), *n* (%)	348 (24.8)
Active or former miners (≥1-year tenure), *n* (%)	1057 (75.2)
Surface only (no underground tenure), *n* (%)	813 (76.9)
Miners with ≥10-year tenure, *n* (%)	763 (72.2)
Active or new miners, *n* (%)	1295 (92.2)
Employed at mine with <50 employees, *n* (%)	427 (33.0)
Respiratory health of active or former miners	1057 (100.0)
Pneumoconiosis	
CWP, *n* (%)	
Miners with 1- to 9-years tenure, *n* (%)	4 (0.6)
Miners with ≥10-year tenure, *n* (%)	23 (3.0)
PMF, *n* (%)	
Miners with 1- to 9-years tenure, *n* (%)	0 (0)
Miners with ≥10-year tenure, *n* (%)	2 (0.3)
Spirometry tests, *n* (%)	575 (54.4)
Abnormal, *n* (%)	52 (9.0)
Obstructive, *n* (%)	11 (1.9)
Restrictive, *n* (%)	41 (7.1)
Mixed, *n* (%)	0 (0)
Smoking history available, *n* (%)	471 (44.5)
Never smoker, *n* (%)	362 (76.9)

Abbreviations: AI/AN, American Indian and Alaska Native; CWHSP, Coal Workers' Health Surveillance Program; CWP, coal workers' pneumoconiosis (i.e., "black lung disease"); NIOSH, National Institute for Occupational Safety and Health; PMF, progressive massive fibrosis.

During the study period, 694 AI/AN miners completed spirometry tests. Of these, 627 tests met repeatability and acceptability criteria, with non-Hispanic White reference values used to interpret 601 (95.9%) tests, Mexican-American/Hispanic reference values used for 25 (4.0%), and African American reference values used for the remaining one (0.1%). After restricting to only active or former miners, 575 miners remained in the analysis (Table 1). Lung function abnormalities were identified in 52 (9.0%) miners with primarily restrictive ($n = 41$) pattern of impairment followed by obstructive ($n = 11$) pattern. Of 471 (44.5%) active or former miners providing health information, 362 (76.9%) were never smokers.

4 | DISCUSSION

This is the first study to use CWHSP data to characterize CWP, PMF, and lung function abnormalities in AI/AN coal miners. Results of radiograph determinations in this study show a higher level of disease prevalence compared to a previous NIOSH study indicating the prevalence of CWP (1.7%) and PMF (0.1%) among coal miners in the western region participating in the CWHSP, though the prevalence of lung function abnormalities was consistent with current findings (7.7%).[2] However, miners in the previous NIOSH study worked predominantly underground and included all races and ethnicities. In contrast, the current study identifies CWP prevalence for both active and former AI/AN miners who were predominantly surface miners.

Spirometry results were available for a subgroup of miners with radiographs during 2014–2019. The CWHSP began offering spirometry in the NIOSH mobile unit in 2005 and in NIOSH-approved clinics in 2016. Thus, some miners had potentially limited access to NIOSH-approved facilities offering spirometry, in particular, in the southwestern United States where over half of the AI/AN miners represented in this study resided.[9] Moreover, some miners were not tested because of spirometry testing contraindications.

Reference values for non-Hispanic Whites were used to interpret spirometry results for AI/AN miners, unless additional race or ethnicity categories were indicated, following current NIOSH guidelines.[8] However, race/ethnicity-based corrections have been contested for producing racial bias.[10] Studies should address race/ethnicity corrections in spirometry interpretation.

Participation in the CWHSP is voluntary. Known participation barriers include difficulties accessing CWHSP approved facilities, discouragement of early disease identification, mistrust and skepticism of medical practices, and fears of retaliation and job loss.[1] Also, AI/AN miners may not be included in the analysis if they did not identify themselves as AI/AN on the questionnaire or may be incorrectly identified if data collectors used personal observation to complete race information.[11] However, these potential biases are more likely to result in underestimation of disease prevalence in the population.[11,12] On the basis of 2014–2019 Census data estimates, approximately 76% of 1859 AI/AN coal miners participated in the CWHSP, which is high compared to previous reports.[1] However, these estimates are subject to sampling error,[4] and participation may be over or underestimated.

Pneumoconiosis in coal miners is entirely preventable. Identification of CWP including PMF in active AI/AN miners indicates a continued need for interventions that prevent dust exposure and diagnose the disease early to limit CWP progression and complication.[1] Primary interventions include dust standards enforcement and the use of dust-limiting engineering controls and the CPDM. Secondary interventions include promoting job transfer options and expanded medical surveillance. Comprehensive demographic data on the coal mining workforce are needed to improve the assessment of CWHSP participation.

ACKNOWLEDGMENTS

The authors would like to thank Dr. Laura Kurth, CDC/NIOSH, and Ms. Delight Satter, CDC/Office of Tribal Affairs and Strategic Alliances, for their review of this manuscript and comments. We also thank the coal miner participants, and the staff of the NIOSH Coal Workers' Health Surveillance Program. This publication was supported by Cooperative Agreement Number NU36OE000006 from the Centers for Disease Control and Prevention and the Association of Schools and Programs of Public Health.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

AUTHOR CONTRIBUTIONS

Noemi Hall: conception or design of the work; the acquisition, analysis, or interpretation of data for the work; drafting the work or revising it critically for important intellectual content; final approval of the version to be published. **Maya Nye**: conception or design of the work; the acquisition, analysis, or interpretation of data for the work; drafting the work or revising it critically for important intellectual content; final approval of the version to be published. **David Blackley**: conception or design of the work; drafting the work or revising it critically for important intellectual content; final approval of the version to be published. **A. Scott Laney**: conception or design of the work; final approval of the version to be published. **Jacek Mazurek**: conception or design of the work; drafting the work or revising it critically for important intellectual content; final approval of the version to be published. **Cara Halldin**: conception or design of the work; drafting the work or revising it critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

DATA AVAILABILITY STATEMENT

Detailed research data are not publicly available due to privacy protections. However, aggregated data are publicly available via NIOSH's Coal Workers Health Surveillance Program's Data Query System found here: https://webappa.cdc.gov/ords/cwhsp-database.html

ETHICS APPROVAL AND INFORMED CONSENT

The work reported here was performed within the Surveillance Branch, Respiratory Health Division, National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention, Morgantown, West Virginia. The NIOSH Coal Workers' Health Surveillance Program (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.

DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily represent the official views of CDC, ASPPH, or the National Institute for Occupational Safety and Health. Mention of a specific product or company does not constitute endorsement by the CDC/NIOSH, or ASPPH.

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REFERENCES

1. Hall NB, Blackley DJ, Halldin CN, Laney AS. Current review of pneumoconiosis among US coal miners. *Curr Environ Health Rep*. 2019;6(3):137-147. doi:10.1007/s40572-019-00237-5
2. Reynolds LE, Blackley DJ, Laney AS, Halldin CN. Respiratory morbidity among U.S. coal miners in states outside of central Appalachia. *Am J Ind Med*. 2017;60(6):513-517. doi:10.1002/ajim.22727
3. Reynolds LE, Blackley DJ, Colinet JF, et al. Work practices and respiratory health status of Appalachian coal miners with progressive massive fibrosis. *J Occup Environ Med*. 2018;60(11):e575-e581. doi:10.1097/jom.0000000000001443
4. U.S. Census Bureau ACS 1-year estimates—Public Use Microdata Sample 2014–2019. 2020. Accessed November 30, 2020. https://www.census.gov/programs-surveys/acs/microdata.html
5. U.S. Mine Safety and Health Administration. Coal Mine Safety & Health Number of miners, 2014–2019. 2020. MSHA at a glance. Accessed November 30, 2020. https://www.msha.gov/msha-glance
6. International Labour Office. *Guidelines for the use of the ILO International Classification of Radiographs of Pneumoconioses*. Revised ed. International Labour Office; 2011.
7. Miller MR. Standardisation of spirometry. *Eur Respir J*. 2005;26(2):319-338. doi:10.1183/09031936.05.00034805
8. National Institute for Occupational Safety and Health. NIOSH Spirometry Training Guide. December 1, 2003. Updated June 6, 2014. Accessed November 20, 2020. https://www.cdc.gov/niosh/docs/2004-154c/
9. National Institute for Occupational Safety and Health. NIOSH-Approved Health Facility Search & Map, Updated February 20, 2020. Accessed November 20, 2020. https://wwwn.cdc.gov/niosh-rhd/cwhsp/FacilityMap.aspx
10. Braun L. Race correction and spirometry: Why history matters. *Chest*. 2021;159(4):1670-1675. doi:10.1016/j.chest.2020.10.046
11. Burhansstipanov L, Satter DE. Office of Management and Budget racial categories and implications for American Indians and Alaska Natives. *Am J Public Health*. 2000;90(11):1720-1723. doi:10.2105/ajph.90.11.1720
12. Laney AS, Attfield MD. Examination of potential sources of bias in the U.S. Coal Workers' Health Surveillance Program. *Am J Public Health*. 2014;104(1):165-170. doi:10.2105/AJPH.2012.301051

How to cite this article: Hall NB, Nye MJ, Blackley DJ, Scott Laney A, Mazurek JM, Halldin CN. Respiratory health of American Indian and Alaska Native coal miners participating in the Coal Workers' Health Surveillance Program, 2014–2019. *Am J Ind Med*. 2022;65:162-165. doi:10.1002/ajim.23324