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Michael Hendryx, PhD; Cynthia Persily, RN, PhD; Jamison Conley, PhD, & Evan Fedorko

*West Virginia Rural Health Research Center
West Virginia University, Morgantown, WV*

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EXECUTIVE SUMMARY

Recent evidence indicates that rates of coal workers' pneumoconiosis (CWP), or black lung disease, after a long period of declining incidence, began to increase in the early 2000s. Safety standards, if adhered to faithfully, should be able to prevent most black lung disease from occurring.

The Health Resources and Services Administration (HRSA) provides grant funding to support Black Lung Clinics for the purpose of finding and serving past and current coal miners. Services provided through this program include outreach, primary care, patient and family education and counseling, care coordination, and pulmonary rehabilitation. The current study addresses two research questions regarding Black Lung Clinics and black lung prevalence: 1) what are the comparative prevalence rates of black lung among active miners in areas closer to, and farther from, Black Lung Clinics, including overall rates and rates by disease severity stage, and 2) within Black Lung Clinic geographic service areas, which areas are showing relatively higher and lower black lung prevalence rates among active miners, overall and by disease severity stage?

Data on the location of HRSA-supported Black Lung Clinics were available from HRSA. Data on black lung prevalence rates were taken from the Enhanced Coal Workers' Health Surveillance Program. The data on cases of CWP were organized on a county level. Cases were classified as showing the presence or absence of CWP, and then were further classified according to the severity of disease progression. Analyses include descriptive and geographic spatial summaries to show the variability in black lung rates in different geographic areas, and in relation to the location of HRSA-funded Black Lung Clinics.

The results indicated that black lung rates overall are significantly higher in areas closer to Black Lung Clinic service areas. The rates are higher for all disease severity stages, but reach statistical significance only for cases at Stage 1 (which is less severe and more common than other stages), and for CWP combined across stages. This finding indicates that Black Lung Clinics have been located in areas of greatest recognized need, where mining activity is most intense and risk of CWP is greater. The spatial analyses indicated that areas of central Appalachia tend to have the most numerous cases of CWP, and also have relatively greater representation of clinic locations compared to areas outside Appalachia. Policy initiatives that may be considered to address the re-emergence of black lung disease include educational outreach efforts that may be undertaken by Black Lung Clinics to encourage employers and miners to achieve better compliance with existing dust control regulations, and efforts by other responsible agencies to improve monitoring and enforcement of regulations as described later in the report.

BACKGROUND

Coal workers' pneumoconiosis (CWP), or black lung disease, is an occupational lung disease caused by inhalation of coal dust. (1). The disease is not curable, is progressive and can advance from simple CWP to progressive massive fibrosis (PMF). PMF is characterized by extensive scarring and thickening of lung tissue, emphysema, and compromised lung function leading to death. In efforts to control CWP, regulations were implemented in U.S. coal mines beginning in 1969 to limit dust exposure levels among workers. These regulations were successful in dramatically lowering disease risk: a 2011 study found that, prior to regulation, PMF was present in 10.3% of autopsies conducted of coal miners who worked exclusively prior to 1969 and had died from any cause, compared to 1.2% of coal miners after regulation who had worked exclusively between 1971 and 1996 (2).

However, recent evidence indicates that rates of coal workers' pneumoconiosis, after a long period of declining incidence, began to increase in the early 2000s (2-6). According to Laney and Attfield (6), prevalence of CWP among active miners was 6.5% in the 1970s, 2.5% in the 1980s, 2.1% in the 1990s and 3.2% in the 2000s. This recent increase is of concern because safety standards should be able to prevent most black lung disease from occurring. The reasons for the increase are not known, although evidence has revealed that the mines most likely to show increases are smaller coal mines (those with fewer than 50 employees) located in some areas of central Appalachia (4,6), and there are concerns that safety regulations at these smaller mines may not be implemented with complete fidelity due to more limited resources at smaller mines. Smaller mines are thought to be less likely to be able to employ industrial hygienists and to purchase state-of-the-art dust suppression systems (3).

Examinations of the recent increase have also shown that some cases have been identified among surface coal miners, who are thought to experience less exposure to respirable dust than underground miners (7). This study found 37 miners out of 2,257 tested who had coal workers' pneumoconiosis but had never worked underground. Exposure to respirable crystalline silica is thought to be a major contributing factor to CWP development, and can occur at surface mining sites in addition to underground sites.

The Health Resources and Services Administration (HRSA) provides grant funding to Black Lung Clinics for the purpose of finding and serving past and current coal miners. Services provided through this program include outreach, primary care, patient and family education and counseling, care coordination, and pulmonary rehabilitation (8). There are 27 such clinics currently in operation in 12 states; these clinics tend to be located in areas proximate to coal mining, but as shown later in this report, there are some clinics located in more distant urban areas, and some mining activity occurs at distances far from the nearest clinics.

Surveillance of black lung rates is undertaken by the National Institute for Occupational Safety and Health (NIOSH) in collaboration with the Department of Labor's Mine Safety and Health Administration (MSHA), through the Enhanced Coal Workers' Health Surveillance Program (3). Surveillance activities take place through the use of mobile examination units in locations where CWP has been identified from prior research as described more fully in the Methods section. The surveillance program targets only active, not former or retired, miners, and so is an underestimate of the total burden of black lung disease in the mining population.

The current study investigates the prevalence rates of black lung disease among active miners in relationship to the location of HRSA-funded Black Lung Clinics. The study will

address two research questions: 1) what are the comparative rates of black lung prevalence in areas closer to, and farther from, Black Lung Clinics, including overall rates and rates by disease severity stage, and 2) within Black Lung Clinic service areas, which areas are showing relatively higher and lower black lung prevalence rates, overall and by disease severity stage?

METHODS

The study is a secondary analysis of existing data on black lung prevalence rates and the locations of Black Lung Clinics. Data on the location of HRSA-supported Black Lung Clinics were available from the agency (9). Locations where Black Lung Clinics are placed are based on grant applications submitted to the federal government by States, or by other private or public entities; grants for specific Clinics are awarded based on availability of funds, a description of the number of miners to be served and their need for services, and on the capacity of the Clinic to deliver services (8). Data on black lung disease rates were taken from the public CDC-NIOSH website (10), which in turn were based on the Enhanced Coal Workers' Health Surveillance Program (3). This surveillance program has been targeted to areas where black lung disease had been identified from prior research, and not necessarily where Black Lung Clinics are located, allowing for the independent assessment of black lung disease prevalence in association with Black Lung Clinic location.

The data on cases of CWP were organized on a county level. Each county that had five or more tested miners over the combined years 2000-2009 was included in the CWP data. Years were combined in order to obtain larger numbers of cases, but the entire covered period represents the period of available data after the time in which the increase in CWP rates was first detected. In cases where a miner may have been tested more than once, only the most recent test result is included.

Testing of miners occurred through chest radiographs, which were then interpreted according to NIOSH-specified quality control procedures (3). Cases were classified as showing the presence or absence of CWP, and then for positive cases were further classified according to the severity of disease progression. Severity of progression ranges from 0 for no clear evidence of CWP, to stages of 1, 2 or 3 showing increasing evidence of CWP, and then to the highest severity rating, which is progressive massive fibrosis (PMF).

Analyses include descriptive and geographic spatial summaries to show the variability in black lung rates in different geographic areas, and in relation to the location of HRSA-funded Black Lung Clinics. For purposes of this study, a county was defined as a Black Lung Clinic service area if it contained a Black Lung Clinic or was adjacent to a county with such a clinic.

RESULTS

Over the time period of the study, 2000-2009, a total of 30,590 coal miners were tested for CWP in the surveillance program. Data are reported for tests that took place in 110 counties within 16 states; all 110 counties had at least five tested miners. Table 1 shows the overall rate of CWP by stage; evidence for CWP at any stage was detected in 2.9% of cases, or 900 miners.

Table 1: Summary of coal workers' pneumoconiosis (CWP) stage for all tested miners (N=30,590) 2000-2009.

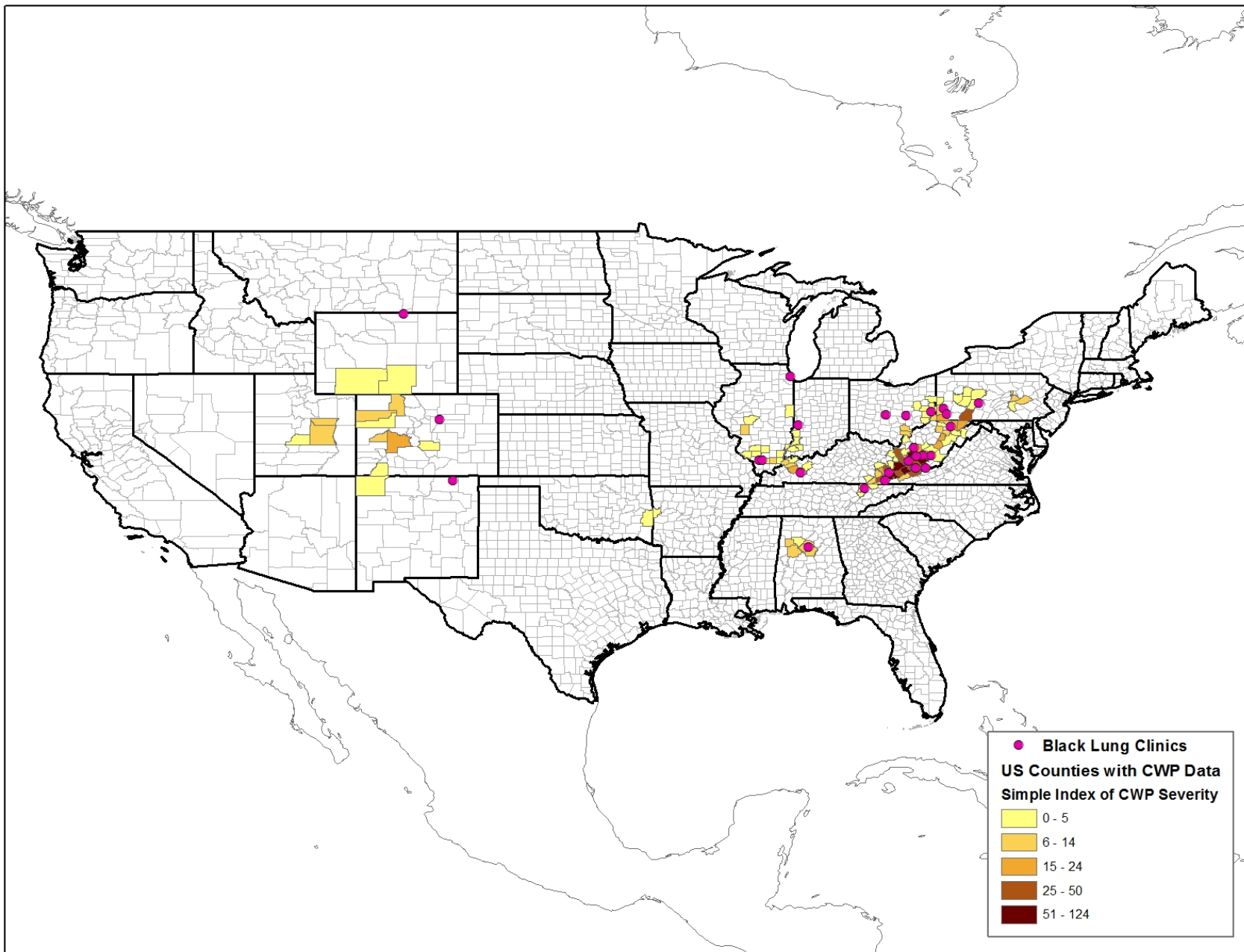
CWP Stage	Number of Miners	Percent of Total
0	29,690	97.1
1	679	2.2
2	106	0.3
3	17	0.1
PMF	98	0.3

Figure 1 shows a map of the location of Black Lung Clinics in relation to CWP test results. The circles represent clinic locations, and the shaded counties show areas where CWP was observed. There are 27 total Black Lung Clinics distributed around the country. Counties with greater CWP severity results are shown in progressively darker shades. The scoring for this measure was based on summing the number of cases in each severity level weighted by severity as follows:

Score for Figure 1 = (number of category PMF (most severe) miners * 4) + (number of stage 3 miners * 3) + (number of stage 2 miners * 2) + (number of stage 1 (least severe) miners * 1).

That is, the shading takes into account both the number of cases and their severity levels. There is a pattern of CWP concentrated in areas of central Appalachia, which is consistent with previous reports (2). This Figure also shows that clinics tend to be located near the surveillance program testing areas, but that there are some clinics that are not close to CWP test areas, and some CWP test areas (especially in the West) are not close to clinics. In some cases, the clinics not proximate to CWP testing areas are located in large urban centers that may serve as specialty referral areas with greater medical resources, including clinics in Chicago, Columbus, and Denver. Additional statistical analyses of spatial autocorrelation and spatial error regression were conducted, but were inconclusive due to the limited geographic coverage of CWP data.

Figure 1: Map showing location of Black Lung Clinics (circles) and count and severity of CWP (shaded counties).



Next, each of the 110 counties in the CWP database was coded to indicate whether or not there was a Black Lung Clinic either in that county or in any county immediately adjacent to it. These counties were equally distributed: clinics were either in or adjacent to 55 tested counties, and were farther away in the other 55 counties. Then, analyses were undertaken to determine whether the percent of tested miners falling within each CWP severity level was significantly different between counties served by, or adjacent to, Black Lung Clinics, compared to counties farther away from Clinics. The groups closer to, and farther from, Black Lung Clinics were compared using two-tailed t-tests. The results are summarized in Table 2.

The Table 2 results indicate that, for cases at Stage 1, and for combined cases across all Stages, there was significantly higher presence of CWP in areas near clinics than in areas farther away from clinics. For CWP cases classified as PMF, State 3 or Stage 2, the differences trended toward higher severity in the areas near clinics, but the results did not reach statistical significance. The table shows that, of all miners tested, approximately 6.2% showed evidence of CWP at any stage in counties closer to clinics, compared to 2.5% of tested miners in areas farther away from clinics. This suggests that clinics have been appropriately located in areas of greatest need as evidenced by the numbers of miners with CWP.

Table 2: Mean percent (and standard deviation) of tested miners in each CWP stage, and combined across stages, in counties that contained, or were adjacent to, a Black Lung Clinic, compared to counties farther away from clinics. P values represent two-tailed t-test results.

	Counties containing, or adjacent to, a clinic (N=55)	Counties not containing, or adjacent to, a clinic (N=55)	
CWP Stage	Percent (standard deviation)	Percent (standard deviation)	P<
1	.0475 (.046)	.0168 (.024)	.0001
2	.006 (.009)	.0042 (.015)	.40
3	.0015 (.004)	.0009 (.003)	.47
PMF	.0067 (.011)	.0032 (.010)	.08
Combined 1 through PMF	.0618 (.054)	.0251 (.036)	.0001

DISCUSSION

The study addressed two research questions: 1) what are the comparative rates of black lung prevalence in areas with and without black lung clinics including overall rates and rates by disease severity stage, and 2) within black lung clinic service areas, which areas are showing relatively higher and lower black lung incidence rates, overall and by disease severity stage.

Regarding the first research question, the results indicated that black lung rates overall are higher in areas closer to Black Lung Clinic service areas. The rates are higher for all disease severity stages, but reach statistical significance only for cases at Stage 1 (which is less severe and more common than other stages), and for CWP combined across stages. This indicates that Black Lung Clinics have been located in areas of greatest recognized need, where mining activity is most intense and risk of CWP is greater. However, there is evidence

that CWP has been observed in some areas of the West that are more distant from the nearest clinic. Given the predominant use of surface mining in the West, and evidence that CWP can occur among surface miners (7), additional research may be useful to examine CWP among Western miners and ensure that appropriate services for CWP are available for these miners. It should also be noted that we would not expect to see significantly lower rates of CWP near Black Lung Clinics, because these clinics are intended to treat, not to prevent, black lung disease.

Regarding the second research question, the spatial analyses indicated that areas of central Appalachia tend to have not only the most cases of CWP, but also the most severe cases. Appalachia also has relatively good representation of clinic locations. Of the 27 Black Lung Clinics in the dataset, 19 (70%) are in or near central Appalachia, including clinics in West Virginia (N=9), Pennsylvania (N=3), Ohio (N=3), Kentucky (N=2), Tennessee (N=1), and Virginia (N=1); these states have among the highest levels of underground mining in the US.

Limitations of the study include the fact that the surveillance program was limited to active miners, and does not include former or retired miners. The rates of CWP are thus underestimated relative to total population impact of the disease. It is unknown what the relationship may be between the presence of Black Lung Clinics and the prevalence and severity of black lung disease among former and retired workers. Investigating this question would be a valuable topic for future research. Due to the limitations of the surveillance program, results for the current study are limited to active miners. A second limitation concerns the potential confound between the presence of Black Lung Clinics and access to care for miners. It is possible, although unknown, that miners in areas with Black Lung Clinics more likely receive testing for CWP through the surveillance program because prior treatment at the clinic has indicated to the miner that there is a problem. However, given that the clearest association between clinic location and CWP was found for Stage 1, which is often asymptomatic (3), it seems unlikely that results can be attributed to prior knowledge of the presence of CWP that prompted miners to be tested. A third limitation is that the severity measure created for Figure 1 was developed for this study, and different severity weighting measures might lead to different patterns, although the measure seems reasonable and agrees with prior literature on the concentration of CWP found in central Appalachia.

CONCLUSIONS & POLICY IMPLICATIONS

The proximity of Black Lung Clinics close to areas of more common CWP cases indicates that Clinics are largely well placed to pursue their mission. In addition, this proximity provides an opportunity to use Clinics as a means to not only treat CWP, which they currently do, but to expand their efforts to prevent future cases from developing. This opportunity arises from the knowledge that CWP can be prevented if safety standards in mines are carefully followed. Black Lung Clinics could take a more proactive role in working with mining operators and employees to improve safety standards for miners. This could be done by expanding and targeting the educational programs that are currently offered to both operators and miners on the importance of following dust control regulations. Programs may be targeted to mining areas that have been identified by prior research as being at the highest risk, such as smaller mines in parts of central Appalachia (4). Additional research is indicated to understand how educational and outreach programs offered by Black Lung Clinics may be made as effective as possible, for example, by understanding how to best reach employees who may be reluctant to pursue services. Clinics may also undertake efforts to expand their geographic reach so they may offer education to prevent CWP, or testing and treatment for CWP, to more areas. Possibilities to

expand this reach include making greater use of telemedicine technology. Another possibility is for Black Lung Clinics to partner with other HRSA-funded clinics such as Federally Qualified Health Centers that may be more proximate to mining populations in some areas to coordinate education, outreach and treatment services.

In addition to education, control of CWP also requires that dust level regulations are enforced uniformly in all mines regardless of size or geographic location. Enforcement of current regulations is the responsibility of MSHA. MSHA has recently increased enforcement efforts, and has also proposed a stricter rule to reduce dust exposure (11,12). This proposal was studied and supported by the Government Accountability Office (13), but has not yet been acted on by Congress.

Treatment of black lung disease is of course a pressing need, but because black lung disease is incurable, policy initiatives to reduce exposure and prevent disease also deserve support. Treatment efforts may focus on ensuring the miners in all areas of the country, including Appalachia, mining areas of the central US, western mines, and elsewhere, have access to appropriate screening and medical services for detection of black lung and for high quality services. The distribution of clinics relative to mining activity and to CWP shows that this is being done well, but could be improved. The ideal way to address black lung is to prevent it from occurring in the first place; to this end, Black Lung Clinics may consider efforts to work with mining officials and miners themselves on the importance of proper dust controls, and MSHA may continue its efforts to implement stricter dust control regulations.

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