Coal Mine Jobs with High Silica Exposure Predict Abnormal Gas Exchange During Exercise

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Rationale: Coal mine dust lung disease (CMDLD) subsumes a spectrum of lung diseases that contributes to significant morbidity and mortality among those exposed. The Federal black lung disability benefits program offers exercise testing in addition to resting spirometry to identify exercise abnormalities. We sought to determine if high dust exposure jobs and other risk factors were predictors of abnormal gas exchange during exercise among a population of coal mine workers examined in one West Virginia clinic. Methods: We analyzed de-identified data from coal miners seen between 2005-2015, in one clinic specializing in Black Lung evaluations. Occupational exposure history, past medical history, spirometry, chest radiograph, and resting and exercise arterial blood gases were obtained. We limited analysis to those with normal resting spirometry (forced vital capacity [FVC] and forced expiratory volume in 1 second [FEV_1] both ≥80% reference and FEV_1/FVC ≥0.70). We defined jobs with high dust exposure as: continuous miner operator/helper; roof bolter; or drill operator. We performed generalized linear regression to estimate predictors of the ratio of measured A-a gradient at peak exercise as a percentage of reference values (based on age from the abbreviated alveolar air equation [Raymond LW. Chest. 1978;74:675-6]). We tested these independent predictors: job titles associated with high dust exposure, total years of coal mine employment, abnormal chest radiograph consistent with pneumoconiosis (defined as ILO category>1/0), cigarette smoking (pack-years), body mass index (BMI), and history of diabetes or coronary artery or autoimmune disease. Results: Of 5,507 miners undergoing testing 2005-2015, 883 were included in this analysis. The median A-a gradient at peak exercise was 18.5 (IQR 13.3-25.25) mmHg, 97.58% (IQR 69.30-132.10%) of predicted. The statistically significant predictors for increased exercise A-a gradient were: high-dust-exposure job (p=0.03), increased BMI (p<0.01), increased smoking pack-years (p<0.01), and chest radiograph consistent with pneumoconiosis (p<0.01) (see Table). The model R^2= 0.16. Limiting the analysis to those without radiographic pneumoconiosis (n=394), high-dust-exposure job, BMI, and smoking pack-years remained statistically significant predictors of increased A-a gradient during exercise (all p<0.05). Discussion: In coal miners with normal spirometry, jobs with greater dust were associated with abnormal gas exchange, even after taking into account total years of work and abnormal chest radiograph. These data underscore the limitations of resting spirometry in dust-exposed coal miners. These data also raise the specter that selected jobs carry exposures of particular risk, which may arise from coal dust or co-exposure to silica from rock neighboring the coal seam.

Table 1. Generalized linear regression model with means and frequencies of predictor variables					
Predictor	Mean (± SD)	Frequency (%)	Coefficient	Standard Error	p-value
Coal mining employment (years)	26.7 ± 8.2		-0.003	0.002	0.14
High Silica Position (yes/no)		543 (61%)	0.071	0.033	0.031
Abnormal Chest X-ray (yes/no)		522 (56%)	0.271	0.033	<0.01
Tobacco pack-years (packsyears)[1]	12.7 ± 16.7		0.003	0.001	<0.01
Body mass index (kg/m^2)	30.9 ± 5.0		0.028	0.003	<0.01
Diabetes (yes/no)		230 (26%)	-0.053	0.038	0.17
Coronary artery disease (yes/no)		215 (22%)	-0.069	0.039	0.07
Autoimmune disease (yes/no)		39 (4%)	0.11	0.077	0.15

[1]Smoking history: Never smokers n=380 (43.2%), Former smoker n=409 (46.3%), Current smokers n=95 (10.6%)