

Smoking Cessation among Coal Miners as Predicted by Baseline Respiratory Function and Symptoms: A 5-Year Prospective Study

RICHARD G. AMES, PH.D., M.P.H.,^{*,†,1} AND DAVID S. HALL, PH.D.[†]

**Appalachian Laboratory for Occupational Safety and Health, and †Department of Community Medicine, School of Medicine, West Virginia University, Morgantown, West Virginia 26505*

A prospective analysis was used to test whether respiratory impairment or the presence of respiratory symptoms predicts 5-year cigarette smoking cessation in a sample of 1,118 U.S. white, male, underground coal miners. Miners were examined in 1977 and re-examined in 1982 by NIOSH, and all miners with test abnormalities were so informed by letter. Respiratory impairment was measured by an index of airways obstruction combining the spirometric measures of Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 sec (FEV₁). Bronchitis symptoms were measured by an index that combined chronic cough (3+ months/year) and chronic phlegm (3+ months/year). Among these coal miners, the presence of chronic respiratory symptoms initially was inversely associated with cigarette smoking cessation. Respiratory impairment, however, was positively associated with cigarette smoking cessation but did not reach statistical significance. © 1985 Academic Press, Inc.

INTRODUCTION

Many studies have addressed the issue of whether cigarette smoking cessation leads to improved health status. Mounting evidence indicates that cessation is associated with reduced mortality and morbidity (10, 14, 21, 24). An important, closely related, but virtually unstudied, question is whether respiratory system impairment of a type likely to be associated with cigarette smoking provides an inducement for smoking cessation. One study to address this issue was that of Loss *et al.* (17) who found that only 7% of subjects who were informed of abnormal lung function or respiratory symptoms at a screening session had stopped smoking at a 6-month follow-up. This paper pursues this line of inquiry by examining the possible link between respiratory health and cigarette smoking cessation in white, male, underground coal miners, an occupational group of relatively homogeneous social status in which both cigarette smoking and work-related respiratory exposures have been salient public health concerns.

We test the specific hypothesis that respiratory impairment and the presence of chronic respiratory symptoms predict cigarette smoking cessation.

DATA AND METHODS

The data in this paper derive from an ongoing National Institute for Occupational Safety and Health (NIOSH) study and are drawn from 1,118 white, male,

¹ To whom reprint requests should be addressed at: NIOSH/ALOSH, 944 Chestnut Ridge Road, Morgantown, W. Va. 26505.

U.S. underground coal miners from mines in Kentucky, Colorado, and Utah. Since the original use of these data was to compare miners from diesel-equipped mines with nondiesel mines, the mine selection called for matched pairs of diesel and nondiesel mines. For each mine selected, participation by all miners was sought. Participation rates were less than desired and ranged from 60 to over 90%. These miners were examined at the mine site in 1977 and similarly re-examined in 1982 by teams of NIOSH-trained staff using a mobile facility. Respiratory symptom and function measurements, chest radiographs, age, education, smoking status, and years of underground mining (a proxy for coal mine dust exposure) were obtained by examinations and questionnaires. These questionnaires were administered by trained interviewers using a standard NIOSH interview protocol. All miners were sent letters informing them of any test abnormalities. A detailed description of the sample selection and measurement procedures is available elsewhere (1).

Baseline measures for the independent, or predictor, variables of respiratory function and respiratory symptoms were obtained at the start of the 5-year interval. Spirometric measures of Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 sec (FEV_1) were combined to form FEV_1/FVC , an index of airways obstruction (22). A bronchitis index with scores from 0 to 2 was formed combining the presence of chronic cough (3+ months/year) and chronic phlegm (3+ months/year) (22). These respiratory symptoms were measured by a modified British Medical Research Council (BMRC) questionnaire (20).

Cigarette smoking cessation, the dependent variable, was measured at the end of the 5-year period. Of the 467 miners who were smokers in 1977, 122, or 26.1%, reported themselves to have stopped smoking by the time they were restudied in 1982. Inquiring as to whether miners are current smokers at one point in time and dichotomizing them at a subsequent time into "current smokers" or "quitters" provides only an arbitrary and approximate measurement of cessation, because many smokers undergo episodes of quitting and thus may be categorized incorrectly at both the start and end of the interval.

A logistic regression model (5) involving prospective prediction of smoking cessation from baseline information was employed. The model included as predictors the previously cited indexes of airways obstruction and bronchitis symptoms, as well as the possibly confounding variables of age, school years, and total years of underground mining.

Two parallel analyses were performed, one for Eastern miners and the other for Western miners. The reason for using two analyses is that the Eastern and Western coal miners differ substantially in many ways. On the average, Eastern miners were older by almost 9 years, completed 2 fewer years of school, and had almost 10 more years of underground mining experience. Nevertheless, both groups had similar rates of smoking cessation: 26.3% for Eastern vs 25.5% for Western miners. The percentage of miners with respiratory impairment, as measured by airways obstruction, was approximately the same in both samples, 24% of Eastern miners vs 23% of Western miners. However, Eastern miners had a higher prevalence of bronchitis symptoms, as shown by an average symptom index of 0.85 vs 0.51 for Western miners.

TABLE 1
LOGISTIC REGRESSION OF SMOKING CESSATION (CONTINUED SMOKING, CEASED SMOKING) AMONG
WHITE, MALE, UNDERGROUND COAL MINERS

Regression model	Eastern miners (N = 361)		Western miners (N = 106)	
	Regression coefficients	Standard error	Regression coefficients	Standard error
Age	-0.01	0.02	0.00	0.03
School years	-0.07	0.05	0.09	0.12
Obstruction index ^a	-0.82	1.60	-1.62	3.52
Bronchitis index ^b	-0.31*	0.15	-0.50	0.35
Total years underground	0.01	0.02	0.05	0.39
Y-Intercept	0.67	1.70	-0.97	3.56

^a (FEV₁/FVC). The smaller the FEV₁/FVC ratio, the greater the respiratory impairment.

^b Sum of cough and phlegm. The higher the index, the greater the prevalence of respiratory symptoms.

* $P < 0.05$.

RESULTS

Among Eastern miners, those with bronchitis symptoms at the start of the 5-year period statistically were *less likely* to cease smoking by the end of the period (Table 1). Eastern miners with airways obstruction were slightly *more likely* to cease smoking than those without obstruction, but the relationship failed to achieve statistical significance.

Among Western miners, the relationships between presence of bronchitis symptoms and smoking cessation and between airways obstruction and cessation were similar to those of the Eastern miners, but presence of bronchitis symptoms failed to achieve statistical significance as a predictor (Table 1).

DISCUSSION

A prospective analysis was used to test whether respiratory impairment or the presence of respiratory symptoms predicts 5-year cigarette smoking cessation in a sample of U.S. white, male, underground coal miners. Two conflicting patterns of evidence were revealed. First, respiratory impairment at the start of the period was positively associated with cigarette smoking cessation, but did not reach statistical significance. Second, prevalence of respiratory symptoms at the start of the period was inversely related to cessation of cigarette smoking, achieving statistical significance among Eastern miners. Loss *et al.* (17) similarly found "normals" to quit smoking at a higher rate than those informed of pulmonary function and respiratory symptom abnormalities.

Coal miners have obvious reasons to be concerned about their respiratory health. Coal mine dust exposure has been implicated in chronic obstructive lung disease (19), and in coal workers' pneumoconiosis, a disease characterized by coal dust retention in the lungs (15). A high degree of worker awareness and salience of these medical conditions is maintained by the existence of the Black Lung Benefits Program (12).

Additional respiratory health concerns have been raised by public health and other professionals concerning special situations where there might be an interaction between coal mine dust, underground diesel emissions, and cigarette smoking (1, 4). Questions have also been raised regarding whether cigarette smoking, rather than coal mine dust, might be the cause of occupational disability in coal miners (18). A test of this hypothesis by one of the authors did not find cigarette smoking to be an independent predictor of early disability retirement among coal miners (3). Additionally, long-term cigarette smoking in interaction with extensive years of underground coal mining has been reported to be a gastric cancer risk factor (2), thus implicating cigarette smoking in nonrespiratory (and noncardiovascular) disease as well. Taken together, these reports indicate that studies of occupational disease in coal miners must include cigarette smoking as a major variable. French *et al.* (9) highlighted the concerns over interaction between cigarette smoking and occupational exposures.

To the extent that respiratory changes are perceived as a threat to one's health, adaptive reaction is suggested. Reactions involving tobacco use can include smoking cessation, which may be permanent or episodic; reduction in the amount smoked; change in the "topography" of smoking—including for example, the proportion of the cigarette smoked or the duration of the puff (8); changing brands to lower tar and nicotine cigarettes; changing to pipe, cigar, snuff, or other "smokeless" tobacco use.

Perceived threat holds especially true for chronic respiratory symptoms because these symptoms are readily apparent to the smoker. In contrast, minor to moderate respiratory function changes, as reflected by spirometry measurements, are less apparent (11) and should be expected to have less impact on smoking cessation.

Evidence supports the case that respiratory symptoms clinically associated with cigarette smoking frequently are interpreted by smokers through such mechanisms as denial of the symptoms, denial that the symptoms are related to cigarette smoking, or interpreting the symptoms to be irreversible (13, 17, 25, 26). Indirect evidence of the use of defense mechanisms exists in reports that many become smokers despite a history of childhood respiratory disease (16), refuse to quit smoking despite physician counseling (23), or even return to smoking following a lung cancer operation (6).

Neither education by itself (7), nor knowledge of the effects of cigarette smoking (27), has been found to predict smoking cessation.

In summary, we conclude that, among cigarette-smoking, white, male coal miners, a group for whom respiratory health is an especially salient issue, the initial presence of chronic respiratory symptoms does not predict subsequent smoking cessation at the end of a predetermined period. Our data, in fact, show an inverse association between symptoms and cigarette smoking cessation. Respiratory impairment, as indexed by spirometry, on the other hand, is positively associated with cigarette smoking cessation, but did not reach statistical significance. Thus, neither an objective nor a subjective measure of threat to coal miners' health appears to predict cigarette smoking cessation. An inference might be drawn that cues provided by respiratory symptoms and respiratory impairment

are being mediated through psychological defense mechanisms, although no direct test of this hypothesis was undertaken. The inverse association between chronic respiratory symptoms and smoking cessation found in this coal miner study, as well as reported by Loss *et al.* in another report, requires further study, especially from the perspective of programs oriented toward smoking cessation.

REFERENCES

1. Ames, R. G., Attfield, M. D., Hankinson, J. L., Hearl, F. J., and Reger, R. B. Acute respiratory effects of exposure to diesel emissions in coal miners. *Amer. Rev. Respir. Dis.* **125**, 39–42 (1982).
2. Ames, R. G. Gastric cancer and coal mine dust exposure. *Cancer* **52**, 1346–1350 (1983).
3. Ames, R. G., and Trent, R. B. Respiratory impairment and symptoms as predictors of early retirement with disability in U.S. underground coal miners. *Amer. J. Public Health* **74**, 837–838 (1984).
4. Barrett, R. E. The federal viewpoint (MSHA), in "Proceedings of a Workshop on the Use of Diesel Equipment in Underground Coal Mines," pp. 6–12. DHHS (NIOSH), Pub. No. 82-122, 1982.
5. Cox, D. R. "The Analysis of Binary Data." Methuen, London, 1970.
6. Davison, A. G., and Duffy, M. Smoking habits of long-term survivors of surgery for lung cancer. *Thorax* **37**, 331–333 (1982).
7. Eisinger, R. A. Psychosocial predictors of smoking behavior change. *Soc. Sci. Med.* **6**, 137–144 (1972).
8. Fredericksen, L. W. Controlled smoking, in "Behavioral Analysis and Treatment of Substance Abuse" (N. A. Krasnegor, Ed.), pp. 128–139. National Institute for Drug Abuse Res. Monogr. Ser. 25, Alcohol, Drug Abuse and Mental Health Admin., DHEW, 1979.
9. French, J. G., Stein, H. P., McKay, W. J., Albright, B. E., Case, G. E., and Howarth, C. I. Interaction between smoking and occupational exposures, in "Smoking and Health: A Report of the Surgeon General," pp. 7.1–7.25. Office on Smoking and Health, DHEW, Washington, D.C., 1979.
10. Friedman, G. D., Petitti, D. B., Bawol, R. D., and Siegelau, A. B. Mortality in cigarette smokers and quitters: Effect of base-line differences. *New Engl. J. Med.* **304**, 1407–1410 (1981).
11. Gottfried, S. D., Altos, M. D., Kelsen, S. G., and Charniack, N. S. Perceptions of changes in airflow resistance in obstructive pulmonary disorders. *Amer. Rev. Respir. Dis.* **124**, 566–570 (1981).
12. Kerr, L. E. Black lung. *J. Pub. Health Policy* **1**, 50–63 (1980).
13. Kristein, M. M. How much can business expect to profit from smoking cessation? *Prev. Med.* **12**, 358–381 (1983).
14. Kuller, L., Meilahn, E., Townsend, M., and Weinberg, G. Control of cigarette smoking from a medical perspective. *Annu. Rev. Public Health* **3**, 153–178 (1982).
15. Lainhart, W. S., Doyle, H. N., Enterline, P. E., Henschel, A., and Kendrick, M. A. "Pneumoconiosis in Appalachian Bituminous Coal Miners." U.S. DHEW, PHS No. 200, Environmental Control Administration, Bureau of Occupational Safety and Health. Cincinnati, Ohio, 1969.
16. Lebowitz, M. D., and Burrows, B. Quantitative relationships between cigarette smoking and chronic productive cough. *Int. J. Epidemiol.* **6**, 107–114 (1977).
17. Loss, R. W., Hall, W. J., and Speers, D. M. Evaluation of early airway disease in smokers: Cost effectiveness of pulmonary function testing. *Amer. J. Med. Sci.* **278**, 27–37 (1979).
18. Morgan, W. K. C. Compensation for industrial lung diseases. The 1973 Baker Lecture. School of Public Health, University of Michigan, Ann Arbor, 1973.
19. Morgan, W. K. C., Burgess, D. B., Jacobson, G., O'Brien, R. J., Pendergrass, E. P., Reger, R. B., and Shoub, E. P. The prevalence of coal workers' pneumoconiosis in U.S. coal miners. *Arch. Environ. Health* **27**, 221–226 (1973).
20. (MRC) Medical Research Council standardized questionnaires on respiratory symptoms. *Brit. Med. J.* **2**, 1665 (1960).

21. Nemery, B., Moavero, N. E., Brasseur, L., and Stanescu, D. C. Changes in lung assessment from a cross-sectional survey. *Amer. Rev. Respir. Dis.* **125**, 144–151 (1982).
22. Parkes, W. R. "Occupational Lung Disorders," 2nd ed. Butterworth's, London, 1982.
23. Pederson, L. L., Baskerville, J. C., and Wanklin, J. M. Multivariate statistical models for predicting change in smoking behavior following physician advice to quit smoking. *Prev. Med.* **11**, 536–549 (1982).
24. Poukkula, A., Huhti, E., and Makarainen, M. Chronic respiratory disease among workers in a pulp mill: A ten-year follow-up study. *Chest* **81**, 285–289 (1982).
25. Purvis, J. M., and Smith, D. L. Smoking among medical students. *South. Med. J.* **69**, 413–416 (1976).
26. Schuman, L. M. The benefits of cessation of smoking. *Chest* **59**, 421–427 (1971).
27. Wynder, E. L., and Hoffmann, D. Tobacco and health: A societal challenge. *New Engl. J. Med.* **300**, 894–903 (1979).