

This article was downloaded by: [CDC Public Health Library & Information Center]

On: 14 August 2013, At: 13:56

Publisher: Routledge

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Archives of Environmental Health: An International Journal

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/vzeh20>

Does Coal Mine Dust Present a Risk for Lung Cancer? A Case-Control Study of U.S. Coal Miners

Richard G. Ames^a, Harlan Amandus^a, Michael Attfield^a, Francis Y. Green^a & Val Vallyathan^a

^a Appalachian Laboratory for Occupational, Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia

Published online: 10 Dec 2012.

To cite this article: Richard G. Ames, Harlan Amandus, Michael Attfield, Francis Y. Green & Val Vallyathan (1983) Does Coal Mine Dust Present a Risk for Lung Cancer? A Case-Control Study of U.S. Coal Miners, Archives of Environmental Health: An International Journal, 38:6, 331-333, DOI: [10.1080/00039896.1983.10545816](https://doi.org/10.1080/00039896.1983.10545816)

To link to this article: <http://dx.doi.org/10.1080/00039896.1983.10545816>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

Does Coal Mine Dust Present a Risk for Lung Cancer?

A Case-Control Study of U.S. Coal Miners

RICHARD G. AMES, Ph.D., M.P.H.
HARLAN AMANDUS
MICHAEL ATTFIELD
FRANCIS Y. GREEN
VAL VALLYATHAN
**Appalachian Laboratory for Occupational
Safety and Health**
944 Chestnut Ridge Road
Morgantown, West Virginia

ABSTRACT. This paper evaluates the relationship between the risk of lung cancer mortality and coal mine dust exposure under control by cigarette smoking status. Two case-control studies based on 317 white male lung cancer mortality cases are presented. A one-to-one matched-case design allows examination of the risk of coal mine dust exposure and cigarette smoking. A two-to-one matched-case design was employed to examine the lung cancer risk of coal mine dust exposure independent of cigarette smoking. Based upon these data, no evidence of a coal mine dust exposure-lung cancer risk was found, although the expected increased risk for lung cancer in cigarette smokers was observed. There was no evidence of an interactive effect between cigarette smoking and coal mine dust exposure.

REPORTS of the relationship between coal mining and lung cancer mortality in Standardized Mortality Ratio (SMR) studies have been inconsistent. Kennaway and Kennaway,¹ Goldman,² Stocks,³ and Liddell⁴ have shown lower than expected lung cancer mortality for coal miners based on figures from Britain. Costello et al.⁵ also found a low SMR from a cohort of Appalachian coal miners in the United States. Elevated rates of lung cancer among coal miners have been reported by Enterline⁶ and Rockette.⁷ Scarano et al.⁸ observed an elevated rate of lung cancer in a series of deaths resulting from anthracosilicosis, which indicates exposure to hard coal mining.

One explanation for these widely differing findings is the lack of adequate control on factors known or

suspected to be related to lung cancer (e.g., cigarette smoking). Costello et al.⁵ and Scarano et al.⁸ did provide some control over cigarette smoking. Generally, however, failure to control adequately on potentially confounding factors could lead to erroneous interpretations of the data.

This paper involves a direct evaluation of the coal mining-lung cancer relationship by focusing specifically on the lung cancer mortality risk of exposure to coal mine dust. Two case-control comparisons aggregating data from four data sets are employed. A one-to-one matched-case analysis—matching on age at death—is employed to examine the lung cancer risk of coal mine dust exposure and cigarette smoking status. A two-to-one matched-case analysis—match-

ing on age at death and smoking status—is employed to examine the lung cancer risk of coal mine dust exposure independent of cigarette smoking.

METHODS

This paper is based on 317 white male lung cancer deaths in the United States from four National Institute of Occupational Safety and Health (NIOSH) coal miner mortality cohorts. The cohorts are:

- (1) *Appalachian cohort*. This is a cohort of over 3,700 bituminous coal miners established in 1963–1965. Mortality follow-up is complete through 1975.
- (2) *National Coal Study, Round #1 Cohort*. This cohort of over 9,000 miners was established in 1969. Mortality follow-up is complete through 1975.
- (3) *Charleston-Beckley Cohort*. This is a regional cohort of over 3,700 miners who filed for compensation under the black lung benefits program. It was established in 1959 and the mortality follow-up is complete through 1975.
- (4) *National Coal Workers' Autopsy Study*. Death certificate data for cause of death determination are used in this analysis. Despite the possibilities of some differences between this cohort and the others, its use is justified on the basis of no known differences between selection of cases and controls in this cohort compared to the other three cohorts.

Case-control methods are used with one series of lung cancer deaths matched in two series to miners who died of non-cancer, non-accident causes. These case-control series are:

- (a) *One-to-one match*. Matches the lung cancer cases one-to-one with miners from the same cohort who died from non-cancer, non-accident causes. Matching was performed on age at death (± 3 yr), and date of birth (± 3 yr). Since no matching was done on cigarette smoking status we can examine the predictive associations to lung cancer mortality of both cigarette smoking and coal mine dust exposure.
- (b) *Two-to-one match*. Matches the lung cancer cases two-to-one with miners from the same cohort who died from non-cancer, non-accident causes.

Matching was performed on age at death (± 3 yr), date of birth (± 3 yr), and cigarette smoking status.

This data set allows analysis of the predictive associations of coal mine dust exposure to lung cancer mortality independent of cigarette smoking status.

A parallel analysis was performed with living controls, matched for age, as an added check against bias resulting from the selection of controls. Since living controls could not be generated for the autopsy cohort, this control operates with a greatly reduced sample size.

Coal mine dust exposure is measured indirectly through years of underground coal mining, an index which has proven useful in research.⁹

Cigarette smoking and occupational history measures are derived from questionnaire data obtained from the miners at the time the cohorts were established. This questionnaire is a modified version of the Medical Research Council (MRC) instrument.¹⁰ Two measures of smoking are employed. Smoking status, at the time of cohort creation, defined 150 of the 1:1 match cases as current smokers, 147 as exsmokers, and 15 as nonsmokers. The smoking status of the 1:1 match controls was 136 current smokers, 115 exsmokers, and 62 nonsmokers. Smoking status was not available for 5 cases and 4 controls. Years smoked, divided at the median, measures smoking duration.

Estimates of Relative Risk (RR) are provided from calculations of the Odds Ratio (OR).¹¹ In the one-to-one matched sample, conventional case-control methods are employed. In the two-to-one matched sample, maximum likelihood ORs are computed based on "case-control₁-control₂" triplets using methods presented by Miettinen¹² and by Rothman and Boice.¹³ Odds Ratios are tested for statistical significance at the 5% level.

RESULTS

Case-control: one-to-one. As expected, current cigarette smoking was a significant risk factor for lung cancer mortality. The OR for risk of lung cancer mortality for current smokers compared with nonsmokers was 4.56 (Table 1).

Table 1.—Odds Ratios for Smoking Status and years of Underground Coal Mining as Lung Cancer Risks: One-to-One Match		
Smoking Status and Years of Underground Coal Mining	Odds Ratio (95% CI)	
	Control series 1 (1:1 match on age at death)	Control series 2 (1:1 match on age living miners [†])
Current smoking status High = current smoker Low = nonsmoker	4.56* (2.48 - 8.39)	27.56* (6.41 - 118.52)
Years of underground mining High = 25+ yr underground Low = <25 yr underground	1.18 (0.86 - 1.62)	0.87 (0.52 - 1.45)
*P < .05.		
[†] Based on 137 cases only. The cases from the autopsy series could not be matched to living controls.		

Table 2.—Odds Ratios for Duration of Cigarette Smoking and Years of Underground Coal Mining as Lung Cancer Risks: Two-to-One Match

Duration of Smoking and Years of Underground Coal Mining	Maximum Likelihood Odds Ratio (95% CI)	
	Control series 1 (2:1 match on age at death and smoking status)	Control series 2 (2:1 match on age and smoking status living miners [†])
Duration of cigarette smoking High = 30+ yr smoked Low = <30 yr smoked	2.28* (1.58 - 3.29)	1.70 (0.92 - 3.14)
Years of underground mining High = 25+ yr underground Low = <25 yr underground	0.89 (0.66 - 1.20)	0.80 (0.48 - 1.32)
For 30+ yr smoked	1.06 (0.73 - 1.55)	0.94 (0.51 - 1.72)
For under 30 yr smoked	0.69 (0.37 - 1.29)	0.36 (0.11 - 1.17)
* <i>P</i> < .05.		
[†] Based on 137 cases only. The cases from the autopsy series could not be matched to living controls.		

Underground mining for 25+ yr, showing extensive coal mine dust exposure, was not a risk factor for lung cancer mortality. The OR for risk of lung cancer mortality for longer vs. shorter term underground mining was 1.18. The OR for the living control check was 0.87, thus indicating essentially no difference resulting from the choice of controls.

Case-control: two-to-one. In the two-to-one matched-case analysis, duration of cigarette smoking achieves statistical significance even with reduced variability under control by current smoking status. Smoking cigarettes 30+ yr doubled the risk of lung cancer mortality (OR = 2.28, see Table 2).

Extensive coal mine dust exposure, 25+ yr of underground mining, was not found to be a risk factor for lung cancer mortality since the OR is 0.89. When control is introduced by stratification on duration of smoking, no evidence of a dust-smoking interaction effect is revealed; ORs are 0.69 for under 30 yr smoked and 1.06 for over 30 yr smoked. The ORs for

the living control check were 0.80, and 0.36 and 0.94, respectively, thus indicating no difference due to the choice of controls.

COMMENT

Based upon these data, cigarette smoking predicts lung cancer mortality in white male coal miners in the United States. There is no evidence that coal mine dust exposure by itself or in interaction with cigarette smoking leads to increased lung cancer mortality.

Dr. Richard G. Ames is on IPA assignment from California State University, Hayward.

Submitted for publication July 25, 1983; accepted for publication August 15, 1983.

Requests for reprints should be sent to Richard G. Ames, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505.

REFERENCES

- Kennaway, F.L., and Kennaway, M.N. 1953. The incidence of cancer of the lung in coal miners in England and Wales. *Br J Cancer* 7: 10-18.
- Goldman, K.P. 1965. Mortality of coal-miners from carcinoma of the lung. *Br J Ind Med* 22: 72-77.
- Stocks, P. 1962. On the death rates from cancer of the stomach and respiratory diseases in 1949-53 among coal miners and other male residents in counties of England and Wales. *Br J Cancer* 16: 592-98.
- Liddell, F.D.K. 1973. Mortality of British coal miners in 1961. *Br J Ind Med* 30: 15-24.
- Costello, J.; Ortmeier, C.E.; and Morgan, W.K.C. 1974. Mortality from lung cancer in U.S. coal miners. *Am J Public Health* 64: 222-24.
- Enterline, P.E. 1972. A review of mortality data for American coal miners. *Ann NY Acad Sci* 200: 260-72.
- Rockette, H. 1977. Mortality among coal miners covered by the UMWA health and retirement funds. Morgantown, WV: U.S. Department of Health, Education, and Welfare.
- Scarano, D.; Fadali, A.M.; and Lemole, G.M. 1972. Carcinoma of the lung and anthracosilicosis. *Chest* 62: 251-54.
- Morgan, W.K.C.; Burgess, D.B.; Jacobson, G.; O'Brien, R.J.; Pendergrass, E.P.; Reger, R.B.; and Shoub, E.P. 1973. The prevalence of coal workers' pneumoconiosis in U.S. coal miners. *Arch Environ Health* 27: 221-26.
- MRC Committee on the Aetiology of Chronic Bronchitis. 1960. Standardized questionnaires on respiratory symptoms. *Br Med J* 2: 1665.
- Masuner, J.S., and Bahn, A.K. 1974. *Epidemiology*, pp. 307-340. Philadelphia: W.B. Saunders.
- Miettinen, O.S. 1970. Estimation of relative risk from individually matched series. *Biometrics* March: 75-86.
- Rothman, K.J., and Boice, J.D. 1979. Program 8. Epidemiologic Analysis with a Programmable Calculator. U.S. Department of Health, Education, and Welfare.