Gastric cancer in coalminers: final report

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ABSTRACT A matched case-control study was conducted to investigate the risk of gastric cancer in coalminers in the southern part of Limburg, The Netherlands. All 683 male cases of gastric cancer were identified at the five pathology departments in the area, all histologically confirmed by a pathologist. For each case a control patient, free of gastric cancer, was selected from the same pathology department, matched on date of birth. Of the 1366 patients enrolled in the study, an occupational history was collected regarding previous employment in a Dutch coal mine. Of the patients with gastric cancer, 28% had been employed as underground workers in a coalmine compared with 25% of the control group. The odds ratio for underground coalmining and gastric cancer was 1.15 (95% confidence limits: 0.89-1.47). There was no evidence for the existence of a dose-response relation. It was concluded that the study did not provide support for the hypothesis that underground coalmining increases the risk of gastric cancer.

Coal is still of great importance to our society as a main source of energy. In 1983 there were 300 000 miners employed in underground coal mining operations within the European Community.¹ Various carcinogenic substances, such as benz(o)pyrene and benz(a)anthracene derivatives, have been identified in coal,² and also inorganic carcinogens such as arsenic, cadmium, and chromium.³ It has also been postulated that dust in general is a risk factor for gastric cancer⁴; inhaled coal dust may reach the gastrointestinal tract through the pulmonary clearance system.

Some investigators have noted a higher incidence of gastric cancer in coalmining areas in Utah⁵ (refuted in a later study⁶) and in Britain.^{7,8} Retrospective cohort studies of coalminers have been carried out by Enterline,⁹ Rockette,¹⁰ and Atuhaire *et al*.¹¹ Enterline reported a standardised mortality ratio of 275 for gastric cancer. In a 30 year follow up study of men in the Rhondda Fach mortality rates from gastric cancer were raised among underground miners.¹¹ This was also true, however, for the non-miners in the study. Rockette followed up a group of about 23 000 coalminers in the United States to investigate their mortality pattern¹⁰ and concluded that "an elevated gastric cancer risk is the third most consistent mortality finding for coalminers behind accidents and pneumoconiosis mortality." In a recent listing of carcinogenic agents and occupations, coalmining was regarded as an occupation associated

with a raised risk of gastric cancer.¹² It has been suggested that other factors such as socioeconomic status may be important in the relation between prolonged exposure to coal dust and gastric cancer.¹³⁻¹⁵ Meyer *et al* postulated that coalminers who do not have an impaired pulmonary clearance system as a result of smoking are at higher risk of gastric cancer than coalminers who do suffer from impaired pulmonary clearance.¹⁶ There is no evidence to support this hypothesis, however. Coalmining in the south east part of The Netherlands has been carried on since the twelfth century. In 1950 over 50 000 workers were employed underground in the area of Limburg. At the end of the 1960s the coal mines were closed since they could not compete with foreign coalmining companies. Many different types of coal were mined, varying from anthracite to bituminous coals. Coal was mined from depths of 3000 feet and one of the mines was regarded as the largest two shaft coal mine in Europe.

Because of the availability of documentation about workers who had been employed in underground mining and the frequent occurrence of past occupational exposure to coal dust, we regarded the area as particularly suitable for conducting a case-control study to investigate the risk of gastric cancer in coalminers. A preliminary report of this study has been published.¹⁷

Material and methods

A total of 683 cases of gastric cancer, all histologically

Table 1 Frequency distribution of main disease categories of the controls, selected from the pathology departments

Disease category	No	%
Circulatory diseases	27	4
Respiratory diseases	56	8
Digestive diseases	144	21
Urogenital diseases	141	20
Diseases of the skin and limbs	103	15
Diseases of internal secretion and sensory organs	18	3
Other diseases	40	6
No abnormality	154	23
Total	683	100

confirmed, was collected at the five pathology departments located in the area. The histological confirmation took place between 1 January 1973 and 31 December 1983. An age matched control patient, free of the disease under investigation, was selected for each case at the same pathology department. It was decided to match on age (date of birth), because the a priori chance of being a coalminer is strongly related to age. The average difference between the dates of birth of the matched pairs was 62 days. The controls were randomly selected from the total patient population of the particular pathology department. Table 1 gives the diagnoses of the controls selected for the study. An underestimation of the true relative risk could have occurred if the control group contained many patients whose primary diagnosis for referral to the pathology department was pneumoconiosis. None of these patients, however, was selected as a control.

For all 1366 patients selected for the study, information was collected regarding their underground mining work. These data were available at the General Mining Fund, a central agency for all coalmining companies in The Netherlands. Since one of the tasks of the General Mining Fund was to keep records on all coalminers regarding their pension rights, an accurate registration existed for all workers who had ever worked underground in a Dutch coal mine. Every coalminer in The Netherlands was obligated to contribute to the General Mining Fund. The records of these contributions are still available for every former coalminer, since they form the basis for the pension benefits to which the contributors are entitled. The files of the General Mining Fund contain information about name, date of birth, address, date of employment, occupation, and by which coal mine the person was employed. These records were searched in a similar fashion for each of the 1366 patients enrolled in the study. In this search the date of birth was used as the personal identification. If the date of birth of a patient matched that of a file of the General Mining Fund the name and address were checked to see if the

Table 2 Frequency of an occupational history of underground coalmining work among 683 matched pairs of male cases of gastric cancer and controls

	Controls		
	With history of underground mining	Without history of underground mining	Total
Cases:			
With history of underground mining	58	132	190
Without history of underground mining	115	378	493
Total	173	510	683

match was correct. For this process it was important to estimate the accuracy of the dates of birth collected at the pathology departments. This was done for the first 500 patients by comparing the dates of birth of those recorded in the Population Registry. Of the 500 patients, only one was recorded incorrectly. For the patients enrolled in the study, for whom a file existed at the General Mining Fund, a short occupational history was recorded about employment in a Dutch coal mine.

The data collected in this study were analysed by means of a matched pair analysis as described by Schlesselman,¹⁸ which is similar to the method proposed by Mantel and Haenszel.¹⁹

Results

The files of the General Mining Fund were searched for all 1366 patients. Of the 683 cases of gastric cancer, 190 had a previous occupational history of underground coalmining. In the control group 173 patients had records showing an occupational history of underground coalmining (see table 2). The odds ratio for underground coalmining was 1.15 (95%

Table 3 Occupational history of underground coalmining work among 683 cases of gastric cancer and 683 age matched controls by duration of employment in the Dutch coal mines

Duration of underground employment (years)	Cases of gastric cancer		Controls, free of gastric cancer	
	No	%	No	%
<1	16	8	14	8
1-5	30	16	29	17
5-10	23	12	22	13
10-20	30	16	29	17
20-30	42	22	45	26
30-40	45	24	30	17
>40	4	2	4	2
Total	190	100	173	100

confidence limits 0.89–1.47), calculated by applying the Mantel-Haenszel method for matched pairs,¹⁹ suggesting no statistically significant raised risk of gastric cancer among underground coalminers.

To study the existence of a dose-response relation a subanalysis was made by duration of underground coalmining work (table 3). There was no increase in risk with a longer duration of employment. The average duration of underground coalmining among the controls was 18.0 years and for the cases 18.8 years.

Discussion

Epidemiological studies investigating the risk of gastric cancer in coalminers have come up with contradictory results. In some studies an excess of gastric cancer was reported whereas in others no excess was found. The results of the study reported here do not indicate that coalminers are at higher risk from gastric cancer. In the study no adjustments were made for other factors that may be important in the development of gastric cancer. Social class is one of the factors that seems to play a part in the aetiology of gastric cancer,^{13 20} low social class apparently being related to a higher risk for gastric cancer. Dutch coalminers before 1947 as a group earned less than the average employee. Of the coalminers included in this study, 79% had coalmining experience before 1947. Thus if social class had a confounding effect on our findings it would most likely have resulted in a bias away from the null hypothesis, resulting in a positive outcome even though in reality there may not be an excess risk of gastric cancer among coalminers. It is also postulated that diet may be important in the aetiology of gastric cancer.²¹ The risks are small, however, and these factors are unlikely to have had a confounding effect in the present study.

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