

RETROSPECTIVE MORTALITY STUDY OF ASBESTOS WORKERS IN LAIYUAN

ZOU SHIQU* • Wu Yongxian • Ma Fusheng* • Ma Hongshuen • Sueng Wenzhi* • Jiang Zhenhuan*

*Dept of Occup. Health, Beijing Medical University, Beijing, 100083, China

A retrospective cohort study was conducted at a chrysotile mine in Laiyuan, Hebei province 1972 and 1981. Mortality rates among 1227 men who had worked at the mine for at least one year before 1972, were compared with those among 2754 local residents of Laiyuan commune who apparently had never been exposed to asbestos. Between 1972 and 1981, there were 67 deaths in the asbestos workers and 247 deaths in the commune residents. Standardized rates of mortality from all cases, malignant tumors and lung cancer were 924.3, 433.6, 344.4 per 100,000 persons in the miners and 836.8, 62.9, 14.3 per 100,000 in the commune residents. The rates of mortality from malignant tumors and lung cancer differed significantly between the two groups ($p < 0.001$). Three cases of mesothelioma were observed in asbestos workers, the mortality rate, 24.9 per 100,000 persons. The lung cancer mortality rate among asbestos workers tended to be higher in 1977-1981 than 1972-1976.

In order to survey the incidence of tumor of asbestos miners and work out the prevention measures of the asbestos hazard, we made retrospective cohort study about the asbestos miners in Laiyuan, Hebei province.

GENERAL INTRODUCTION

The asbestos mine of Laiyuan is located at central-west part of Hebei province; east of Taihang mountain. Its main product is chrysotile. The country rocks are dolomite serpentine, marble and little quartz rock. There were no other industrial pollution sources within 10 kilometers of the asbestos mine. The food was supplied mainly by the Laiyuan city, which is 30 kilometers away from the asbestos mine.

The asbestos in Laiyuan has been exploited for 60 years; after 1949 it was changed into state-run. The output and number of workers began to increase in the late 1950s. This mine was gallery exploited by handwork in the early time. The asbestos selecting rooms of mechanization were put into operation in the latter half of 1954; the dust in the air of working condition was very high, as follows: 1168-1453 mg/m³ gallery drilling, 356.8 mg/m³ dressing. To follow the development of production, the mechanic ore dressing and dust eliminating apparatus was used and then, the dust concentration began to decline. However, the dust concentration in the major dust-producing workplaces still go beyond mg/m³ (which is the national hygienic standard). The dust concentrations over the years are: mining 26.8 ± 4.4 mg/m³ varied 0.5-80 mg/m³; dressing 29.7 ± 4.2 mg/m³ varied 0.5-80 mg/m³. The dust

AED 5 μ m is 80%, free SiO₂ in the original asbestos is 1.5%, the subsiding dust in dressing is 3.6-6.2%.

There are 1500 asbestos miners in the asbestos mine. Many older workers who were employed before 1949, when the mine was established had been exposed to high concentrations of dust. Up to now, the grand total of the asbestosis was 154 and a number of malignant tumors occurred among the asbestos miners.

THE OBJECT OF SURVEY, CONTENT AND METHOD

We investigated the male asbestos miners who registered on January 1st, 1972 and were exposed to asbestos at least one year. We wanted to know their incidence and mortality rate (MR) of malignant tumor, from January 1st, 1972 to December 31st, 1981.

In order to choose the case population, we selected such people in Laiyuan commune to take the control group, their living conditions and medical services are the nearly the same as the asbestos miners. They are never exposed to asbestos and other carcinogens. They registered on January 1st, 1972, and are older than 15 years.

The trained interviewers collected the register of object respectively for the asbestos mine. The register would be collected from labor card and health management card and be examined; for the commune the register would be collected from residence card of the police office. After that, each register would be checked according to questionnaire. The dead was traced for cause from hospital death certification. The smokers were questioned by the survey staffs. Information about the dead was supplied by the relatives or the insiders. The dust concentrations of working environment were supplied by occupational health and safety department of the asbestos mine or local anti-epidemic station in Bao Ding or other unit; the materials of the two groups were standardized for the sake of easy comparison.

RESULTS

The response rate of asbestos miners group and the commune residents group are as follows: 99.9%, 99.3%, the malignant tumors were diagnosed by the county hospital, asbestos mine hospital and other advanced hospital, the lung cancers were diagnosed above grade II (shown in Table I).

1. The death toll of asbestos miners was 67.24 deaths from malignant tumor in which 9 people died from lung cancer (3 mesothelioma). On the other hand the death toll of the commune residents was 246.16 deaths from malignant tumors in which 3 people died from lung cancer. After standardization, the death rate (mentioned above) of asbestos mines are significantly higher than those of the commune residents (Table II). The ratio of standard MR of lung cancer in asbestos mines was 24.

In the cohort study of asbestos miners, there were 154 cases of asbestosis, among which 14 died (7 died from malignant tumors and 6 died of lung cancer). The rate of asbestosis with lung cancer complications is 3.9%. Lung cancer percentage in the death cause of asbestosis is 42.9%.

2. The distribution of two groups of death cause is different. On one hand, in the asbestos mine, the former six death causes were 96% of the total death cause. Its order is as follows: malignant tumor, respiratory disease, stroke, coronary heart disease and other cardiac disease, brain vessel disease. On the other hand the

former six death causes were 83% of the total death cause in the commune, its order is as follows: other heart disease (mainly cor pulmonale), respiratory disease, brain vessels disease, stroke, malignant tumor infectious disease. It is clear that the malignant tumor is the first death cause and 32% of the total death cause in the mine. It is very striking.

3. Lung cancer was 41% of all deaths caused by malignant tumor of asbestos miners, stomach cancer and liver cancer come second. Stomach cancer and esophagus cancer occupy the first death cause, together they are 63% of malignant tumor for commune residents. We should pay much attention that MR of lung cancer of asbestos mine is very high. In addition, there are three cases of mesothelioma which occurred rarely in general population, however, the MR of the mine is so high as to reach 24.91 per 100,000. The trend of MR of malignant tumor from the former five years (1972-1976) and later five years (1977-1981) were 125.4, 152.9 per 100,000 in the miners and 81.8, 24.3 per 100,000 in the commune residents. The prevalence rate of lung cancer is 27.9 in the former five years and 82.3 in the later five

Table I
The Diagnosis Grade of Two Groups

group	tumor category	grade of diagnosis*				total
		I	II	III	IV	
asbestos miners	lung cancer	3(33.3)#	6(66.7)	---	---	9(100.0)
	the others	7(46.7)	8(55.3)	---	---	15(100.0)
commune	lung cancer	---	3(100.0)	---	---	3(100.0)
	the others	---	11(84.6)	2(15.4)	---	13(100.0)

* national census of tumor in 1973-75.

out of the brackets are cases, in the brackets are percentage.

Table II
Comparison of the SMR Between Asbestos Mine and Commune

	all cases	all malignant tumor	lung cancer
asbestos mine	926.3	433.6	344.4
commune	836.8	62.9	14.3
p	0.001	0.001	0.001

years for the asbestos miners, and 13.6 and 6.0 in the commune residents. The trend of MR of all malignant tumor and lung cancer is increasing. This is in accordance with long latency period of lung cancer in the asbestos miners.

DISCUSSION

The reliability and comparison between the exposure group and control group is the key problem of the survey. The response rate of the survey is over 99%, interviewers were all professional and well trained before the survey, the survey was conducted according to the uniform plan. The death cause was confirmed in the clinical service, in which the deceased was diagnosed and confirmed by case report or doctors who were responsible for the dead.

The diagnosis level of malignant tumor between the two groups was similar. All were diagnosed above the county level hospital. 2 cases of malignant tumor in commune residents were diagnosed grade III (12.5% of all malignant tumor); the others were diagnosed grade I-II. In order to achieve the reliability of original material, we checked all the problems of the survey, so we think the material is reliable.

As to the comparability between the control group and exposure group, we think it is comparable, reason: 1) The geography condition and diagnosis level of the two groups are similar. 2) For the commune residents, MR of all death cause, all malignant tumor and lung cancer are similar to those of retrospective cohort study on death cause of Bao Ding area and in Xin Cheng County in 1974-1976, those are nearly Laiyuan. 3) The age constitution of the two groups population is a bit different. This is related to the special age constitution of asbestos miners; this problem can be solved by standardization. After standardization, we find that the indices of the asbestos miners which include, MR of all death causes, all malignant tumor and lung cancer are higher than that of the commune residents. Its difference is significant. It implies that there are special factors which make the MR of lung cancer of asbestos miners higher than that of the commune residents.

We should analyze the reason why the SMR of malignant tumor is higher than that of the commune residents. Beside the difference of the lung cancer between the two groups, the SMR of stomach cancer of asbestos miners is higher than that of commune residents. The SMR of lung cancer will increase in such conditions: industry population and smoking. There are no industrial sources of high incidence of lung cancer near the local district. On the contrary, the commune residents whose living and natural conditions are similar to the asbestos mine, have lower prevalence of lung cancer than the asbestos miners. The survey on the death cause in 1979 to 1981 showed the rude MR of lung cancer in Bao Ding city was 8.17 per 100,000, the country side of Xing Cheng 8.22 per 100,000, the commune residents 9.63. These are lower than that of the asbestos mine. It implies that the industry pollution or the local reasons which make the high incidence of the lung cancer of the asbestos mine do not exist.

The material of the recent years proved that lung cancer is closely associated with smoking, but this survey indicates that the MR of lung cancer has no significant relationship with

smoking in miners (p 0.1) and with smoking in commune residents (p 0.9).

The survey also indicates that smoking is not the main cause which makes the higher MR of lung cancer of the asbestos miners, but people who smoke and are exposed to asbestos have much higher MR of lung cancer than those who smoke without exposure to asbestos at the same time (p 0.01).

The relationship between the death from lung cancer and type of job or year of asbestos exposure is shown in the following:

Exposure (years)	5	5-	15-	25
Incidence of lung cancer (%)	0	0.35	0.61	2.42

The relationship of the incidence of lung cancer and the year of asbestos exposure dust is as follows:

$$(y=0.1035x - 0.9433 \quad x: \text{year} \quad y: \text{incidence} (\%) \quad r=0.918 \quad p 0.01).$$

The relationship between the incidence of lung cancer and type of job is as follows: miller 1.44%; management of production 1.33%.

The materials show that the incidence of lung cancer is associated with purity of asbestos and exposed time. This is the same as the general report, that the incidence of lung cancer of asbestos processing is higher than that of asbestos mining.

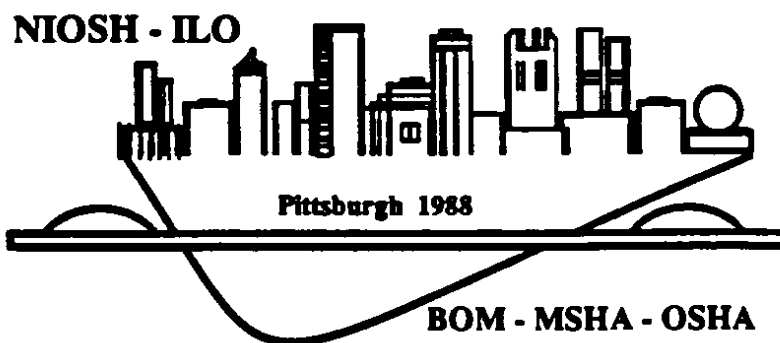
We can come to the conclusion that the high MR of lung cancer is mainly associated with asbestos. The shortest time of cancer onset is 24 years, the longest time is thirty-two and four months. The mean value is 28.18 years (28.18 ± 0.83). The cancer worsened quickly after diagnosis, the time from diagnosis to death is about six months (6.33 ± 2.08). There is no discovery of the lung cancer among the miners whose exposure to asbestos is less than 5 years. In this survey three cases of mesothelioma were found. The cause of death from malignant tumor in the general population is about 1-3 per 100,000, but in the asbestos mine of Laiyuan it is as high as 4479 per 100,000.

SUMMARY

1. The retrospective cohort study was conducted at chrysotile mine and comparison was made with commune residents in Laiyuan during 1972-1981. The SMR from all cases, malignant tumor, and lung cancer were 924.3, 433.6, 344.4 per 100,000 persons in the miners and 836.8, 62.9, 14.3 per 100,000 in the commune residents. The SMR of malignant tumor and lung cancer differed significantly between the two groups (p 0.001).
2. The MR of the lung cancer of the asbestos mine is closely associated with dust of asbestos. Smoking and exposure asbestos can make the MR of lung cancer increase. Abstinence of smoking and no smoking should be advocated among the asbestos exposed workers.
3. The trend of the MR of lung cancer in the asbestos mine in Laiyuan is ascending. All this predicts that the peak of the lung cancer of this asbestos mine is coming, so it is important to take steps to prevent it.

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