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Occupational Cancer Epidemiology in the People's Republic of China

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The practice of occupational cancer epidemiology in China began in the 1970s. Prior to that time, occupational diseases were evaluated only by industrial hygiene practitioners and through rudimentary surveillance, and there was little awareness that the epidemiologic approach was applicable to occupational problems. Most of the industries in China have been developed since 1949, and during the early stages of development, when scientific and technologic experience was limited, the effects of occupational agents on workers were not well recognized. By the mid-1970s, however, the problems of occupational hazards in China gradually emerged. Reports of excesses in cancer incidence among workers in specific industries followed one after another: these attracted the attention of governments, health professionals, managers, and workers. To determine the extent of occupational hazards in China and to develop preventive measures. Chinese health professionals began using epidemiologic method8 to study occupational hazards among workers exposed to various occupational agents.

With the implementation of a more open policy, the scientific and technologic exchanges between China and other countries will increase; therefore, a brief introduction to the current status of epidemiologic studies of occupational cancer in China is warranted.

Practitioners of Occupational Epidemiology in China

In China. most practitioners of occupational epidemiology are associated with one of the following types of agencies: (1) national and provincial (or city) institutes of health under the Ministry of Public Health. such as the Institute of Occupational Medicine in Beijing or the Shanghai Institute of Labor Hygiene; (2) departments of public health in the national medical schools, such as the School of Public Health, Beijing Medical University; (3) institutes of occupational health under ministries other than Public Health, such as the Institute of Industrial Health, under the Anshan Iron and Steel Company of the Ministry of Heavy Industry; and (4) the antiepidemic stations under provinces or cities, such as the Zhejiang Antiepidemic Station.

Currently in China there are 170 institutes of occupational health and antiepidemic stations, and about 2,500 professionals for occupational health. Four regulations on occupational health, 124 hygiene standards (maximum allowance concentration [MAC]), and 20 diagnostic criteria have been promulgated. Annually, approximately $3,000,000 is spent for the prevention and treatment of occupational diseases.

Some Characteristics of Current Methodology

As in other countries, the major methods used for occupational epidemiologic study of cancer in China are the retrospective cohort mortality study and the case-control study. Some prospective cohort studies have been based on retrospective cohort studies; however. no results of prospective cohort studies had been reported in China until recently.

Although basic epidemiologic methods used in China are in theory similar to those used in other countries. the identification of cohort members and follow-up of vital status. as well as the collection of death certificates, are quite different. In China. identification of cohort members is based on payroll records (i.e., pay sheets) on which names of all persons who have worked at a factory are listed monthly according to departments and job categories. These records are maintained by the Department of Labor and Capital in the facility and are a very convenient means of identifying cohort members. In addition, there is a cumulative personnel system in which detailed records for every worker from initial work experience to death are recorded and transferred to a master file maintained by the government. This

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provides a source from which detailed data on vital status of cohort members can be obtained. Also, the vital status of cohort members can be traced through the local police station from which every citizen must get food coupons, as part of a current system of grain rationing. Birth and death records, as well as the relocation of persons, are current and kept in good order in the local police station.

All salaried persons in China may avail themselves of public health services and are assigned to health care facilities, from the small clinic located in their place of employment to the general and specialized hospitals of the provinces and cities. Therefore, death certificates and medical histories of deceased workers can be obtained from the medical recorda at hospitals at various levels of government.

The mobility of Chinese citizens is not as great as that of citizens in other countries with different social systems and customs. Workers and staff reside close to previous employment locations after retiring, because these are the sources of their monthly retirement pay. As a result, follow-up rates of more than 95% can be reached with little effort.

Some Important Occupational Epidemiologic Studies in China

Most occupational epidemiologic research in China has been carried out since 1970. Eight major studies have been performed and will be summarized. All are retrospective cohort mortality studies.

Vinyl Chloride

The cohort is composed of 5,958 workers who worked at one of 14 major production facilities for at least 1 year. between 1958 and 1981.[1] Of the 14 vinyl chloride facilities. most were built in the 1960s, with the earliest in 1958 and the latest in 1970. Prior to 1970, the concentration of vinyl chloride monomer in these facilities was high (Table 1). Since the late 1970s. the quality of industrial hygiene at these facilities has been distinctly improved: however, the vinyl chloride concentration in air at several work places has remained fairly high due to manual operations in several of the production processes, especially in the cleaning of the reactor. Table 1 shows the vinyl chloride concentrations at one of these facilities after the control technology was improved.' These levels are still greater than the standard of 1 ppm recommended by the National Institute for Occupational Safety and Health for the United States.

The results of this study showed no excess risk of mortality from all deaths, all malignancies, liver cancer. or any other malignant neoplasms among workers exposed to vinyl chloride. Also. no angiosarcoma was diagnosed among vinyl chloride/polyvinyl chloride workers. nor was there an association of incidence and mortality with job categories, extent of exposure, or latency. The authors suggested that the results may be due to a short latency period (85% of cases had latencies of 10 years or less) since most of the facilities were built in the 1960s. The prevalence rates for hepatomegaly and splenomegaly among workers in this study has been found to be markedly increased. In one of these vinyl chloride facilities. the prevalence rate due to splenomegaly was 9%. The prevalence rate for hepatomegaly was 10% in 1973, 20% in 1975. and 25% in 1980.[2] More recently, a prospective cohort study of workers exposed to vinyl chloride has been conducted in China.'

Chloromethyl Methyl Ether (CMME) and Bis(chloromethyl) Ether (BCME)

Most of the plants producing CMME and BCME in China were built between the late 1950s and the early 1970s. Exposure data maintained in the plants were incomplete: however, according to the records obtained from one of Shanghai's CMME plants in 1977 to 1978, the exposure of CMME level ranged from 1.2 to 59 ppm.[3] Before 1977, the air CMME concentration at the workshops in the plants may have been much higher.

The retrospective cohort study included workers exposed to CMME for at least 1 year in any of the 10 plants producing CMME." The cohort included 915 workers (534 men and 381 women). From the beginning of operations through 1981.15 deaths due to lung cancer were observed and 0.97 were expected (using Shanghai death rates as a reference), yielding a standardized mortality ratio (SMR) of 1,546 (95% confidence interval (CI) = 944. 2.531).

Excesses in mortality from all causes and all malignancies were also observed due to the excess of lung cancer deaths. The study indicated that mortality from lung cancer among workers exposed to CMME and BCME was related to the extent of CMME exposure, and no association between lung cancer mortality and cigarette smoking was found. Cigarette smoking was assessed by interview of kin and co-workers.[3]

Of the 15 cases of lung cancer, 11 had a histologic diagnosis. Eight of these 11 were confirmed to be undifferentiated cell cancers and three were squamous cell cancers. The age at death of workers who died from lung cancer ranged from 32 to 64 years, with an average of 50 years. which is 10 years younger than would have been expected if the mortality rates of Shanghai applied to the cohort.[3]

Benzidine

Benzidine has been manufactured in China since 1956: prior to that time it was imported.' In 1977. the use and production of benzidine was stopped due to its carcinogenicity.

The retrospective cohort study of benzidine manufacturing plants included 2.525 workers (1,860 men and 665 women) exposed to benzidine for at least 1 year. from 1972 through 1981. The control workers were from plants with no exposure to benzidine. naphthylamines. 4-aminobiphenyl. or other aromatic amines. A relative

TABLE 1
Concentration of Vinyl Chloride in a Production Facility

Sampling Location	1978		1981	
	Samples	Average, ppm (range)	Samples	Average, ppm (range)
Synthetic-control room	13	18 (0.5–214 0)	20	3.9 (0.5–68.6)
Synthetic room at building	13	76.9 (14 2–367 0)	22	56.2 (1.6–636.0)
Compressor room 1	12	469.4 (144.0–4600.0)	23	221.9 (40.8–1540.0)
Compressor room 2	12	84.9 (3.9-4900.0)	22	35.2 (5.5–380.1)
Polymerizing room	13	60.8 (8.7–244.0)	23	24.8 (0.5–163.0)
Polymerizing control room	12	1.3 (0.5–75.1)	23	3.3 (0.5–61.6)
Basic processing	10	9.4 (3.5–145.0)	23	15.4 (0.5–262.8)
	12	5.7 (0.5–76.5)	23	15.5 (0.5–235.1)
Packing	12	4.8 (0.5–17.5)	16	3.1 (0.5–20.4)

TABLE 2
Interaction Between Benzidine Exposure and Cigarette Smoking in the Development of Bladder Cancer

Groups	Benzidine	Smoking	Incidence per 10^{4}	RR	P
Control	–	–	1.36	1.00	–
	–	+	8.45	6.21	.05
Case (cohort)	+	–	86.15	63.35	<.05
	+	+	207.13	152.30	<0.01

risk (RR) was calculated as the ratio of the crude mortality rate (per 100,000) in the exposed cohort divided by the crude mortality rate in a control cohort. Among male workers exposed to benzidine, 102 deaths from all causes were observed with a RR of 1.4 (90% CI = 1.1. 1.82); 52 deaths and 71 incident cases due to all malignancies resulted in a RR of 2.07 (90% CI = 1.4, 3.0) for mortality, and a RR of 2.7 (90% CI = 1.9. 39) for incidence.'

Specific attention was given to the mortality from and incidence of bladder cancer among workers exposed to benzidine. Twelve deaths and 30 Incident cases due to bladder cancer were found, yielding a RR of 12.80 (90% CI = 3.4, 48.3) for mortality and a RR of 32.20 (90% CI = 11.2, 99.6) for incidence. Thirty cases of bladder cancer observed *vs* 1.15 cases expected based on the experience of Shanghai's general population, standardized by age, sex, and calendar year, resulted in a standardized incidence ratio of 2,610 (90% CI = 1.878. 3,538). In addition, mortality from and incidence of lung cancer and stomach cancer were also slightly in excess. The 39 cases of bladder cancer observed in the study were all confirmed as transitional epithelial cancer. Of these, 35 cases were diagnosed as papillary and four as infiltrating. The study also suggested a synergistic effect of benzidine and cigarette smoking upon the development of bladder cancer in workers (Table 2). After analyzing the incidence of bladder cancer among workers exposed to benzidine, by calendar year, the authors noted that it seemed to be increasing and has not peaked:

Asbestos

The retrospective cohort study of asbestos included nine asbestos product manufacturers and five asbestos mines located in various districts in China Findings for manufacturing and mining will be discussed separately.

Nine Asbestos Product Manufacturers. Most of the nine asbestos product manufacturing plants were built 30 years ago.[5] The principal asbestos used was chrysotile. Although exposure levels for asbestos dust in these manufacturing plants have decreased markedly in the past three decades due to improvements in technology and engineering, the asbestos dust concentration at the workshops until 1982, when this study was conducted. greatly exceeded the current standard (2 mg/m^3) in China. Fig. 1 display8 the average asbestos dust levels between 1956 and 1981 as determined from 297 samples obtained from five raw material departments.[6]

The cohort members for the retrospective cohort study of nine asbestos product manufacturers were 10,095 workers who had been exposed to asbestos for at least 1 year before 1972. The follow-up of vital status began in 1972 and continued through 1981.[6]

The results showed that the workers exposed to asbestos at manufacturing plants had a significant excess risk of death compared with control workers who had not been exposed to asbestos. The mortality rates (per 100.000) for all causes. all malignancies, and lung cancer were 522 (752 men, 238 women), 170 (240 men: 83 women), and 67.4 (93 men: 36 women), respectively. Malignancies were observed to be the leading cause for all deaths, and lung cancer was the most common malignancy. The SMR for lung cancer is 633 (90% CI = 474,830). The latency for lung cancer ranged from 8.0 to 34.0 years with an average of 21.7 years. The excess risk of lung cancer among workers exposed to asbestos was found to be related to job, latency, and extent of

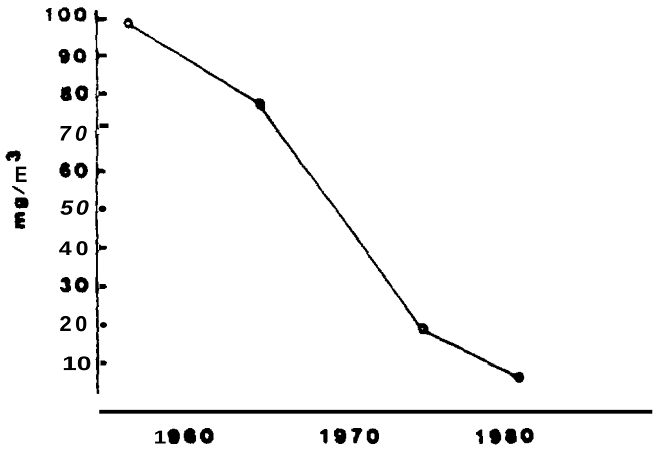

Fig. 1. Average asbestos dust levels in five plants between 1956 and 1981.

TABLE 3
Relationship Between Cigarette Smoking and Lung Cancer Among Workers Exposed to Asbestos

Exposure to Asbestos	Smoking	Cases	Non-cases	RR
–	–	1	2.030	1.0
–	+	4	3.110	2.6
+	–	6	1.044	11.7
+	+	26	2,148	24.6

exposure. Table 3 shows a clear association between cigarette smoking and an excess risk of lung cancer among workers exposed to asbestos. Only one mesothelioma was observed in this retrospective cohort study.'

Five **Asbestos Mines.** These five mines are the largest asbestos mines in China. with an operating history of more than 30 years. In the past. manual work in these mines was very common and the exposure level extremely high. Although the air concentration of asbestos dust at the mines has declined remarkably since 1955 due to a wet operating method instead of a dry operating method. the exposure level substantially exceeded the current standard ($2\ mg/m^3$) in China, sometimes a 100-fold. Airborne asbestos dust in the environment of some residential districts around the mines was also high.[5]

The retrospective cohort study of five asbestos mines included 6.193 workers who had been exposed to asbestos for at least 1 year before Jan 1, 1972. Vital status was observed from 1972 through 1981. The results were similar to those observed in the study of asbestos product manufacturers. that is, excess risk due to all causes. all malignancies. and lung cancer. The SMR for lung cancer was 940 (90% CI = 610, 1.416). Again. the excess risk of lung cancer was found to be related to job categories. latency, extent of exposure. and cigarette smoking habits of these workers.'

Benzene

In this retrospective cohort study, 28,460 cohort members (15.643 men. 12.817 women) who had been exposed to benzene for at least 1 year from 1972 through 1981. were identified from 233 plants located in 12 cities in China.' The results indicate that mortality for all causes. all malignancies. and leukemia among the workers exposed to benzene is increased significantly (Table 4). Twenty five deaths observed for leukemia *vs* 4.36 deaths expected based on unexposed control workers. or 5.45 deaths expected based on the population of the specific city, resulted in a SMR of 574 (90% CI = 398, 800) or 459 (90% CI = 318, 640), respectively. Exposure levels for 25 leukemia patients varied from 3.3 to 313.5 ppm according to records kept in the plants. Latency for leukemia among workers exposed to benzene ranged from *0.8* to 48.5 years with en average of 11.4 years. The age of leukemia patients ranged from 24 to 62 years. with an average of 39.7 years.[8]

An excess risk due to leukemia among workers exposed to benzene was found to be related to the extent of exposure, job title, latency, and history of chronic benzene intoxication. Of 30 leukemia cases, most (76.7%) were diagnosed as acute leukemia. In this study, excess risk for lung cancer among workers exposed to benzene was also observed (SMR = 231. 90% CI = 196, 271).

In addition, a matched case-control study was conducted to study further the relationship between workers exposed to benzene and leukemia. Cases were selected from three large hospitals, and controls were patients from the same hospitals who had no hematopoietic disease. A threefold excess exposure to benzene for cases of leukemia was observed.'

Arsenic

Cohort members were identified from the following facilities: (1) a copper ore-smelter, (2) a secondary copper smelter: (3) an arsenic smelter: and (4) an arsenic-bearing ore mine. These facilities have a long operating history and were built before the 1930s.[7] In the early years. working conditions were primitive and simple: manual work was very common. and the air at work sites was severely polluted by arsenic. Although control technologies in these plants and mines had been improved since the 1950s. arsenic levels remained high. The situation was so bad at the arsenic smelting plants that the authorities closed down some of the operations in 1977.'

It is noteworthy that both workers and miners. as well as family members. had drunk mineral spring water containing arsenic from natural sources for a long time. The retrospective cohort study included workers exposed to arsenic from 1972 to 1981—18.795 Person-years at risk. The results indicated that malignancies were the leading cause of death, and that lung cancer was the leading malignancy. The forty deaths observed from lung cancer resulted in an SMR of 678 (90% CI = 511. 882), based on control workers' death rates. directly standardized by age. sex, and calendar years. This study found a strong dose-response relationship between lung cancer and air arsenic concentration. The latency period for lung cancer among workers exposed

TABLE 4
Mortality from All Causes, All Malignancies, and Leukemia Among Workers Exposed to Benzene

	Case Subject			Control Subject			AR	P
	PYAR*	Deaths	Death Rates (10^{-5})	PYAR	Deaths	Death Rates (10^{-5})		
All causes								
Men	100.025	394	393.90	121.268.5	236	194.61	2.02	<.01
Women	78.531	80	101.87	77,932.5	41	52.61	1.94	<.01
Total	178.556	474	265.46	199.2010	277	139.06	191	<.01
All malignancies								
Men	100.025	187	187.0	121,268.5	91	75.04	2.49	<.01
Women	78,531	33	42.0	77,932.5	18	23.10	1.82	<.05
Total	178.556	220	123.0	199,2010	109	54.74	2.25	<.01
Leukemia								
Men	100,005	17	17.0	121,268.5	3	2.47	6.88	<.01
Women	78,531	8	10.2	77,932.5	1	1.28	7.24	<.05
Total	178.556	25	14.0	199.2010	4	2.01	6.97	<.01

* PYAR, person-years at risk.

to arsenic ranged from 6 to 31 years. with an average of 22.9 years.'

Chromate

The chief raw materials used for producing chromate are chromite, sodium carbonate, limestone, and dolomite. The products include sodium bichromate, potassium dichromate. chromic acid, and chromic sulfate. Based on incomplete exposure data recorded in the plants. the exposure levels from 1963 through 1980 varied from 0.020 to 21.33 mg/m^3. The air chromate levels at some work sites at times have been much higher.'

In the retrospective cohort study, 2,982 workers exposed to chromate for at least 1 year before 1981 were identified from seven chromate manufacturers in seven large cities. Excess risk for all causes. all malignancies. and, specifically, lung cancer among workers exposed to chromate was observed. Malignancies were the leading causes of death. The death rates for male and female workers due to all malignancies were 141.08/100,000 and 88.05/100,000, respectively; these figures were much higher than those of control workers (99.9/100,000 and 8.4/100,000, respectively). The author attributes this finding for female workers to employment in more dangerous jobs.'

Eleven death from lung cancer were observed among male workers exposed to chromate, and resulted in a RR of 2.7 (90% CI = 1.3. 5.5) when compared with the rates for the control workers not exposed to chromate. The latency period for lung cancer among workers exposed to chromate ranged from 2.2 to 20.3 years, with an average of 11.7 years. The average age of workers diagnosed as having lung cancer was 55.6 years: this was 8.2 years less than the average for control workers.'

The study also found that excess risk due to lung cancer among workers exposed to chromate was related to latency, extent of exposure and smoking habits of workers. In addition. there was an increasing tendency for cancer of the esophagus among male workers exposed to chromate, and for cancer of the breast among the female workers.'

Coking, Gas, Carbon, and Oil Refinery Plants

Coking Plants. Nineteen coking plants. which included almost all of the coking plants in the metallurgical industry in China. were studied. Three of the plants were built prior to the 1930s, seven prior to the 1950s. and nine prior to the 1960s.[9] The cohort comprised 21,995 workers who had worked at any of the 19 coking plants before 1966. Follow-up of vital status of cohort members began in 1971 and continued through 1982. a total of 12 years.

A comparison group was chosen from workers in a primary rolling mill (steel company). An excess risk of death due to lung cancer among coking plant workers was observed (standardized risk ratio [SRR] = 2.55. 90% CI = 2.13. 3.03). There was also an increased risk for all causes of death and all malignancies among coking plant workers (Table 5). The excess risk of lung cancer among coking plant workers was significantly related to job title. Among workers in the coking plants. the highest mortality from lung cancer was observed in the coking departments. especially among workers at the top or side of the coking oven. The differences in risk of lung cancer observed among workers with different job titles were consistent with extent of exposure to the emission from the coking oven. mainly with exposure to benzo(a)pyrene. In addition, mortality from lung cancer among coking workers was observed only after 15 years of latency. The peak of the death rate for lung cancer was reached after a latency of 30 years. The authors concluded that the excess risk of lung cancer among coke oven workers in the steel company was related to benzo(a)pyrene.[9]

Coal Gas Plants. The study cohort comprised 3,107 workers from six coal gas plants and the comparison group was from workers in a steel rolling mill: 234 deaths for all causes (SRR = 1.29. 90% CI = 1.16, 1.44) were identified among workers who were employed in 1971 and who died during the next 10 years. One hundred nine of those deaths were for all malignancies (SRR = 1.73, 90% CI = 1.46. 2.02). The study showed that. from 1971 through 1981. the standardized risk ratio for lung cancer among workers who worked in the

TABLE 5
Risk of Lung Cancer for Coking Plant workers

Causes of Death	Observed	Expected	SRR	P
All causes	837	628.77	1.33	<.01
All malignancies	291	198.52	1.47	4.01
Lung cancer	93	36.44	2.55	<.01
Coking department	53	12.03	4.41	< 01
Coking oven	40	8.05	4.97	<.01
Top of Oven	13	0.52	8.59	<.01
Side of Oven	15	3.05	4.91	<.01
Non-coking oven	13	3.98	3.27	<.01
Department of Preparing Coal	12	4.84	2.48	<.01

gas departments of the coal gas plants was very high (SRR = 3.66, 90% CI = 2.36, 5.43), and related to latency. Among these workers there was also an excess risk of cancers of the digestive tract.[9]

Carbon. The raw materials used in producing carbon are smokeless coal, coke, and pitch. The air pitch concentration at work sites in the carbon plants has been as high as 40 mg/m^3. During the early years of operation, environmental contamination at the work sites was extraordinarily severe.[9]

In this retrospective cohort study, 5,122 cohort members in two carbon plants built in the 1950s were studied. Workers in a steel rolling mill were used as a control group. A total of 227 deaths from all causes (SRR = 1.24, 90% CI = 1.1 1, 1.39) were observed; these included 80 deaths from all malignancies (SRR = 1.33. 90% CI = 1.09, 1.60), and 24 deaths from lung cancer (SRR = 2.60, 90% CI = 1.79. 3.60). Lung cancer was observed to be a leading cause of death for carbon plant workers. The excess risk of lung cancer observed among cohort workers was associated with extent of exposure to pitch. and displayed an exposure-response relationship. In the study, there was an excess risk for diseases of the circulatory, respiratory, and digestive systems.'

Oil Refining and Synthetic Oil Plants. One retrospective cohort study was conducted in shale oil refining plant built in the 1920s. Data obtained in 1975 indicated that air benzo(a)pyrene levels at the plant ranged from 2.0 to 12.40 $\mu g/100\ m^3$. The air benzo(a)pyrene level on the top of an oven at one of the departments reached 33.69 $\mu g/100\ m^3$. In among the 6,285 members of the study cohort. there were *657* deaths from all causes: 182 deaths from all malignancies. and 46 deaths from lung cancer. Based on age- and sex-specific death rates for the local population, the SMRs were 141 (90% CI = 124, 159) for all malignancies, including lung cancer and cancer of the esophagus. 240 (90% CI = 185, 307) for lung cancer. and 244 (90% CI = 157, 311) for cancer of the esophagus. The excess risk of cancers of the lung and esophagus was found to be related to the title and latency.'

The second retrospective cohort study was conducted in three oil refining plants built in the 1960s. The cohort comprised 12,422 workers. There were 313 deaths from all causes, and 80 deaths from malignancies. of which 26 were from liver cancer. SRRs were calculated based on the experience of a population of workers in a steel rolling mill. In this study, an excess risk of mortality was observed for liver cancer only (SRR = 1.99. 90% CI = 1.27. 2.99). especially among workers who worked in the fuel oil-producing department (SRR = 3.88, 90% CI = 1.99. 6.68). No excess risk of lung cancer was found.

The third retrospective cohort study, which included 3,774 workers, was conducted in a synthetic oil plant built in the 1940s. SRRs were calculated as in the previous study. In this plant, oil was made from coal *gas* in a process that involved a cobalt catalyst contaminated with radioactive elements. During the early years of the operation, the environment in this plant was severely polluted by emissions from the coal gas ovens and by radioactive thorium and radon daughters emitted during the production process. A total of 200 deaths from all causes were observed, including 74 deaths from all malignancies, of which 20 were from lung cancer. Excess risks of all malignancies. lung cancer, and digestive tract cancer were found, with SRRs of 1.35 (90% CI = 1.10, 1.64), 2.02 (90% CI = 1.34, 2.93), and 1.56 (90% CI = 1.13, 2.09), respectively. Results showed that the mortality from lung cancer was significantly related to job title and extent of exposure.'

Prospects and Problems

As China itself is developing, so is its practice of occupational epidemiology. These retrospective cohort mortality studies covered eight categories of known carcinogens in 460 factories or mines in various geographic areas of China. The studies involved 93,500 cohort members (988,572 person-years) and 63,000 controls (646,744 person-years). The findings presented in this paper generally are consistent with findings of studies performed in other countries.[10-18] *An* exception is the vinyl chloride retrospective cohort study; however, the latency period for angiosarcoma in that study was relatively short. These studies of Chinese industries formed the basis for making and maintaining lists of carcinogens, so that in the future effective protective intervention measures can be taken. and strategies can be developed for other occupational epidemiologic studies. In addition. these studies have been training experiences in occupational epidemiology for many health professionals.

Today, based on these retrospective cohort studies. some new epidemiologic studies and updating of past cohort studies are being conducted. As mentioned. most of the industries in China were built in the 1950s, when working conditions at the plants or mines were unsatisfactory, environmental pollution in the air was a serious problem. and exposure levels for workers were too high. After 30 years. the severity of occupational hazards in the plants and mines has been gradually revealed. and is now being controlled to some extent. There are still many occupational hazards and a great need for occupational epidemiologic studies. and, compared with other countries. occupational epidemiology in China is underdeveloped. For example, there are no up-to-date national population death rates specific by sex. age. race. and calendar years. Advanced computer techniques are not used extensively in epidemiologic studies. No life-table analysis computer program has been developed in China. Many complicated calculations rely on manual work and a simple calculator. For this reason, approaches using direct standardization and internal comparison groups have been used and probably will continue to be used. In addition, the methods of the International Classification of Diseases published by the World Health Organization have not been applied to China's occupational epidemiologic research. Consequently, the comparisons of results with those of studies outside of China is often difficult. Sampling methods and analytic techniques for the entire nation need improvement and standardization. The reporting system for occupational diseases is not complete.

Finally, it is clear that recent attention to epidemiologic studies in China has focused mainly on the well-known carcinogens. Up to the present, no comprehensive national data base on workplace hazards has been developed. To obtain basic information on the extent of exposure to hazardous chemicals in industry, the severity of the health effects from chemicals, and the number of workers exposed to hazardous chemicals, it may be necessary to organize a national occupational health surveillance program using medical screening, industrial hygiene surveys, and even biomonitoring methods. Such an occupational health surveillance program could provide baseline information on hazards and facilitate the observation of epidemiologically significant changes in work-related diseases, injuries, disabilities and mortalities. New occupational health problems and previously unrecognized high-risk groups can also be identified.[17,18] Some prominent institutes of health in China—for example, the Institute of Occupational Medicine of the Chinese Academy of Preventive Medicine under the Ministry of Public Health—must bear the responsibility for developing such surveillance systems. However, it must be emphasized that successful control of occupational disease, to a great extent, also depends on implementation of prevention and occupational control programs. Epidemiologic research can play a part in focusing all these activities. It is clear from the studies described in this paper that the first step has been taken.

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